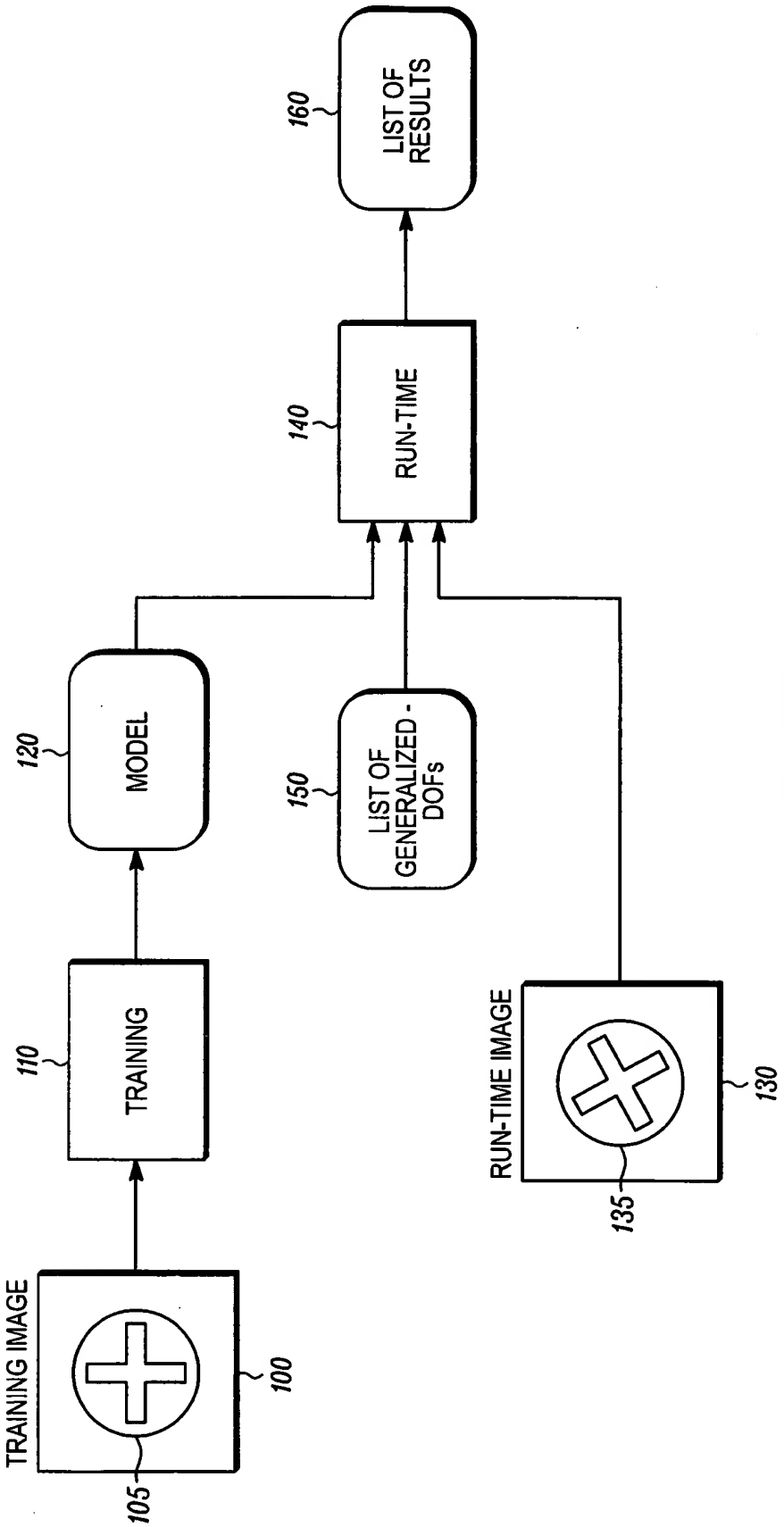
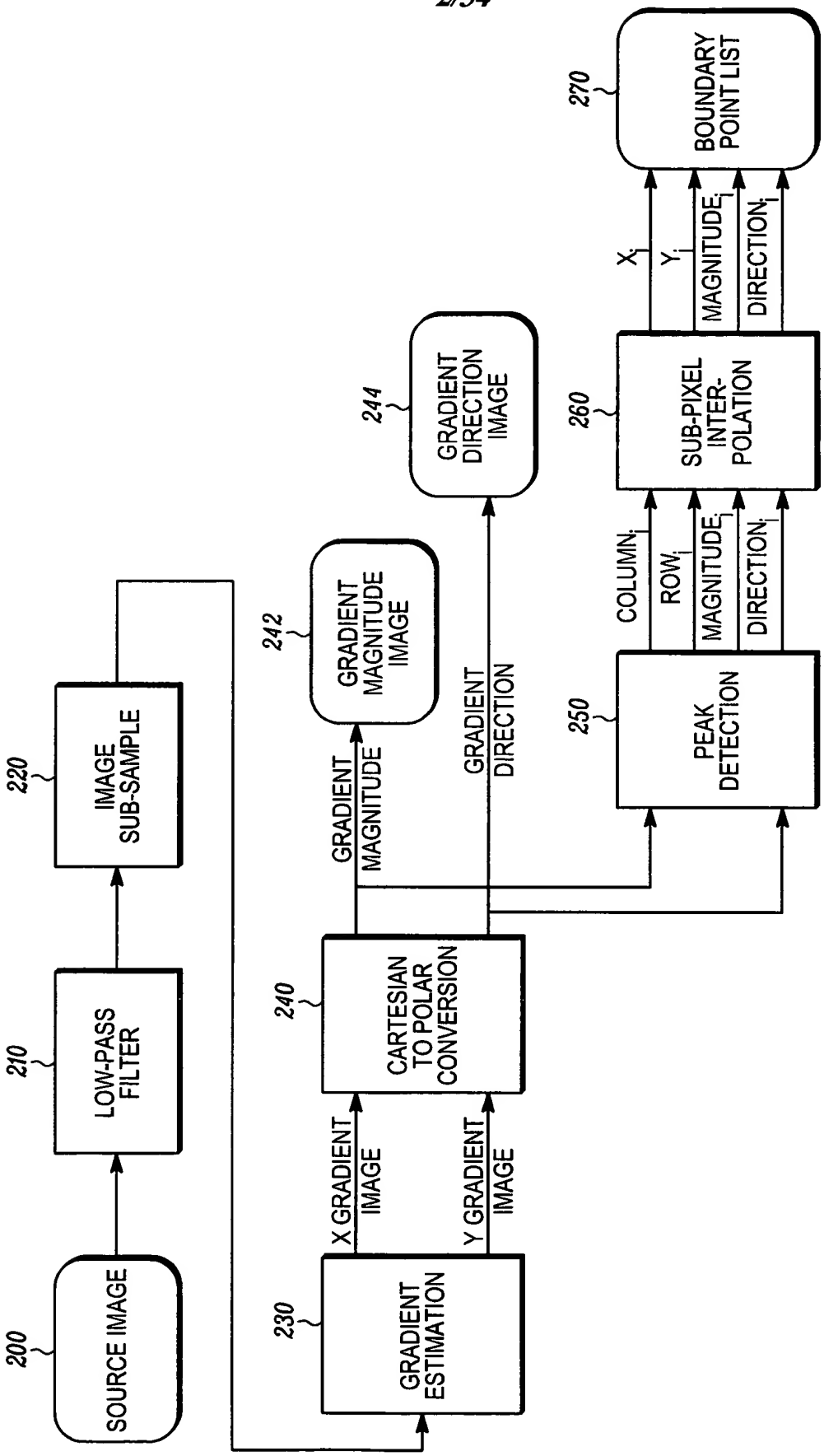


BLOCK DIAGRAM

FIG. 1



GRANULARITY CONTROL, GRADIENT, AND BOUNDARY DETECTION

FIG. 2

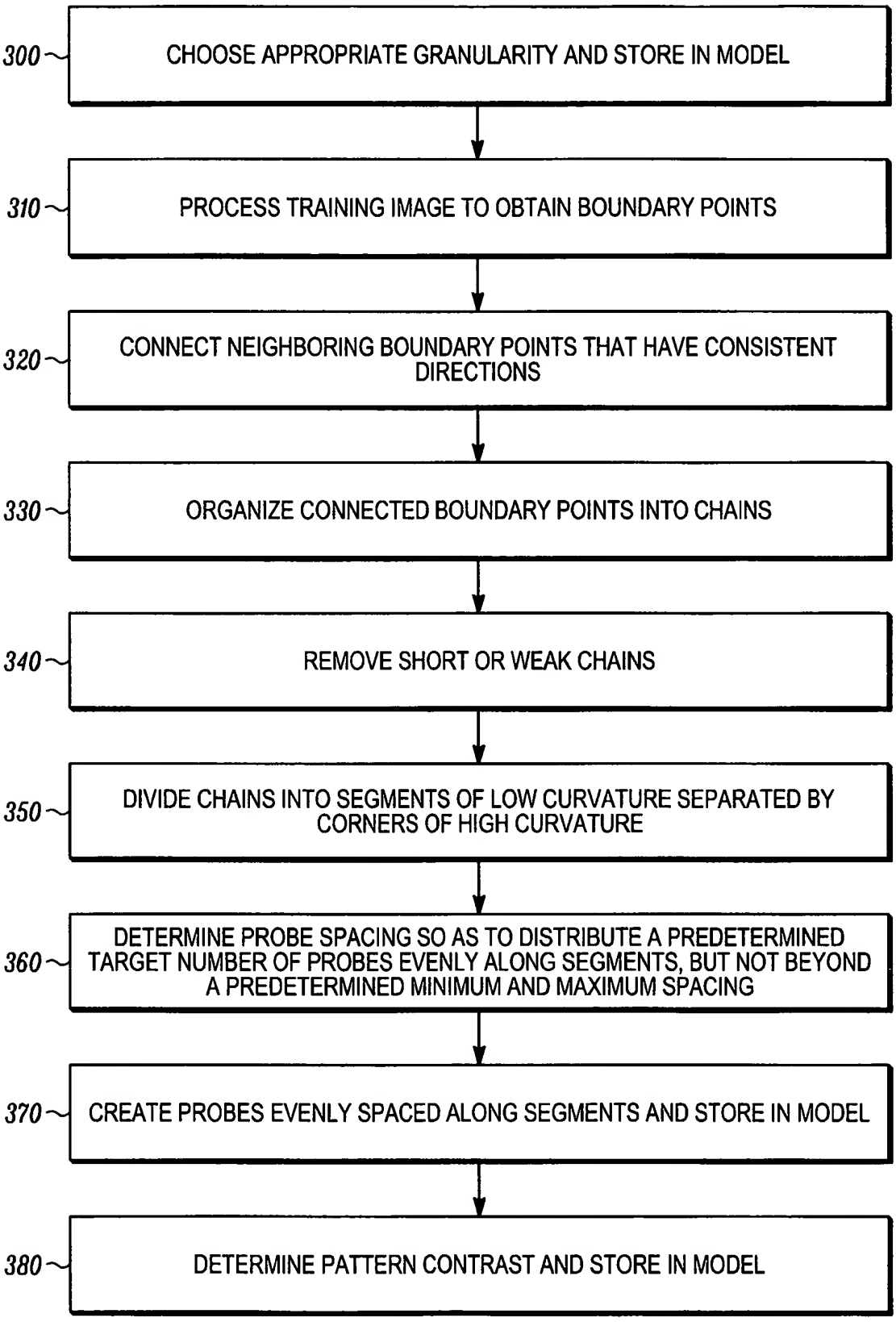
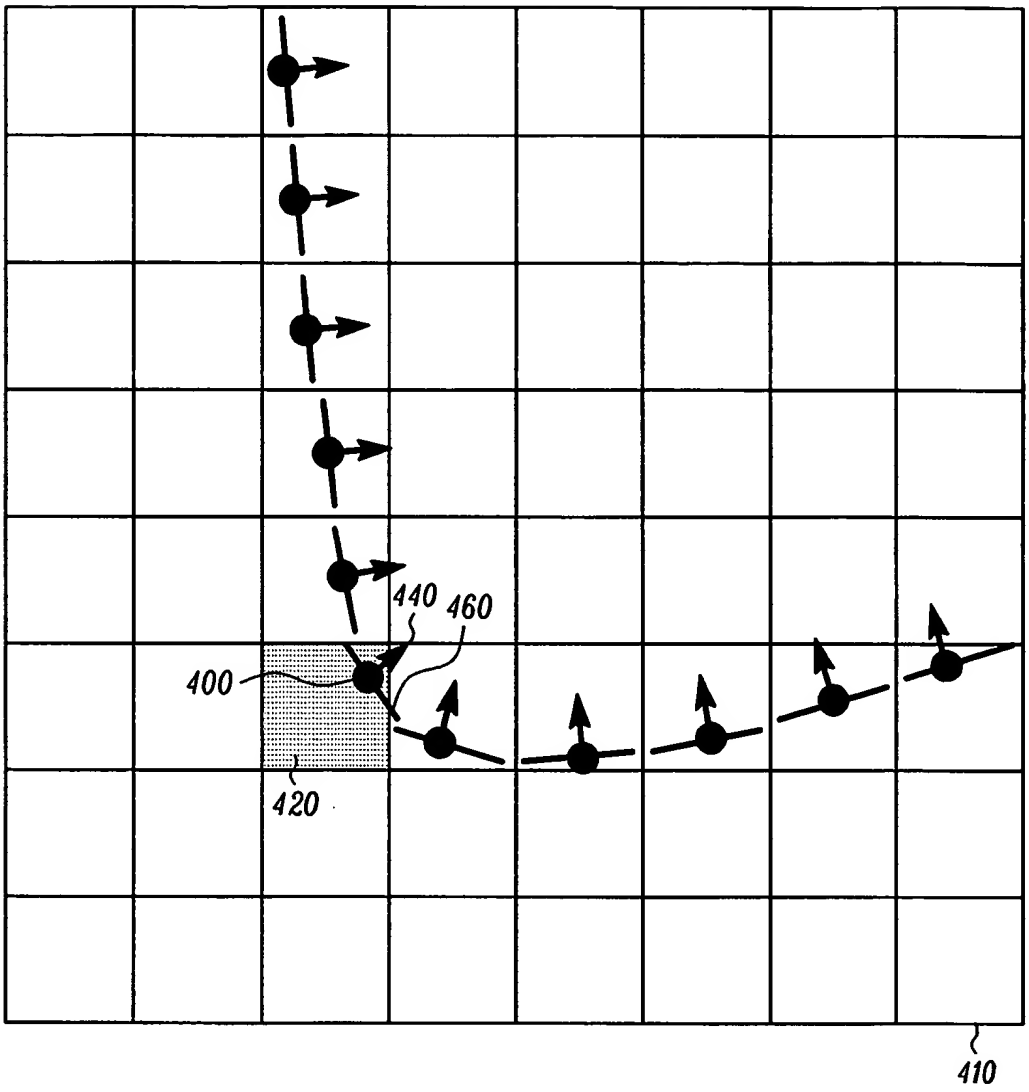
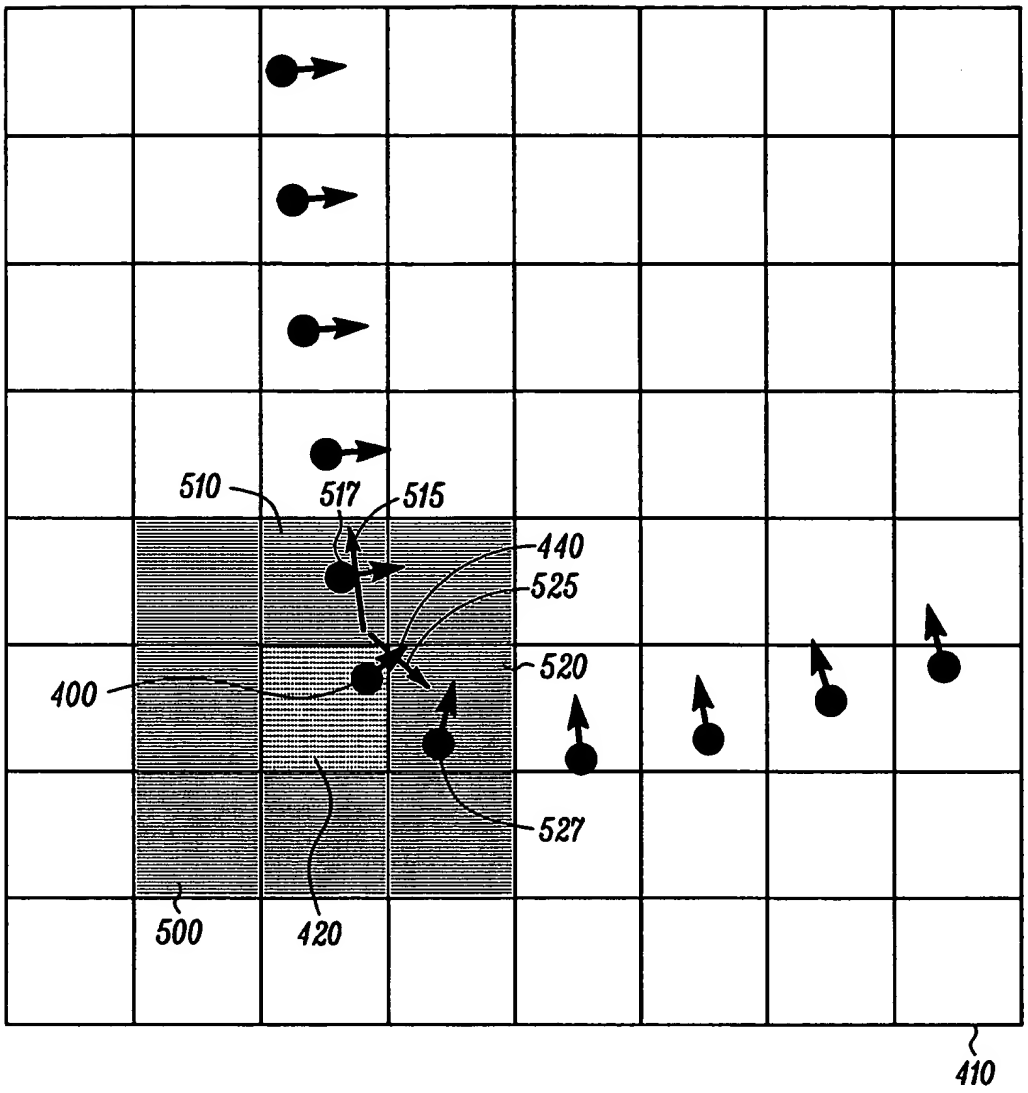


FIG. 3 TRAINING FLOW CHART



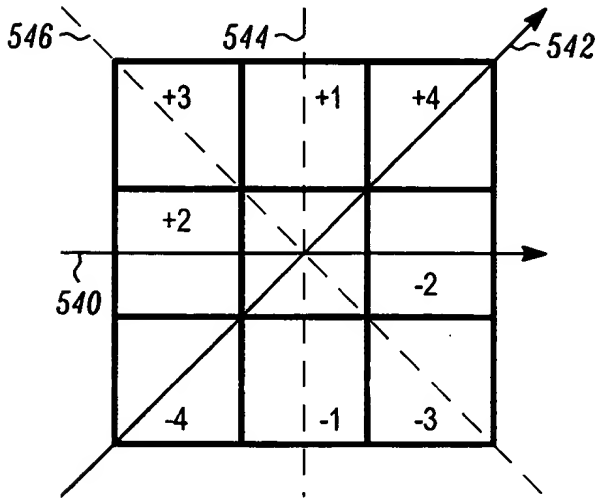
BOUNDARY POINTS

FIG. 4



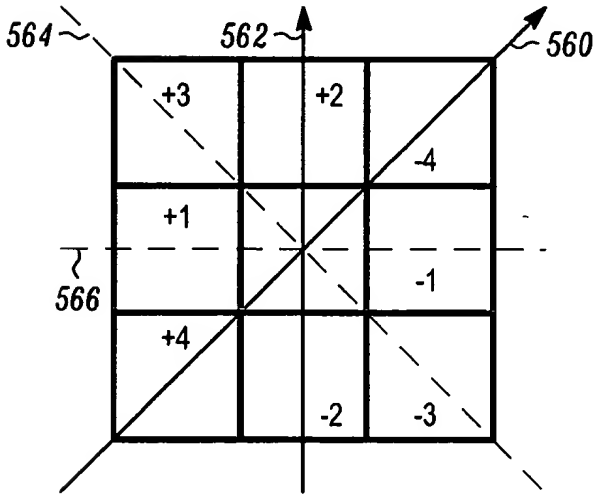
BOUNDARY POINT CONNECTING

FIG. 5A



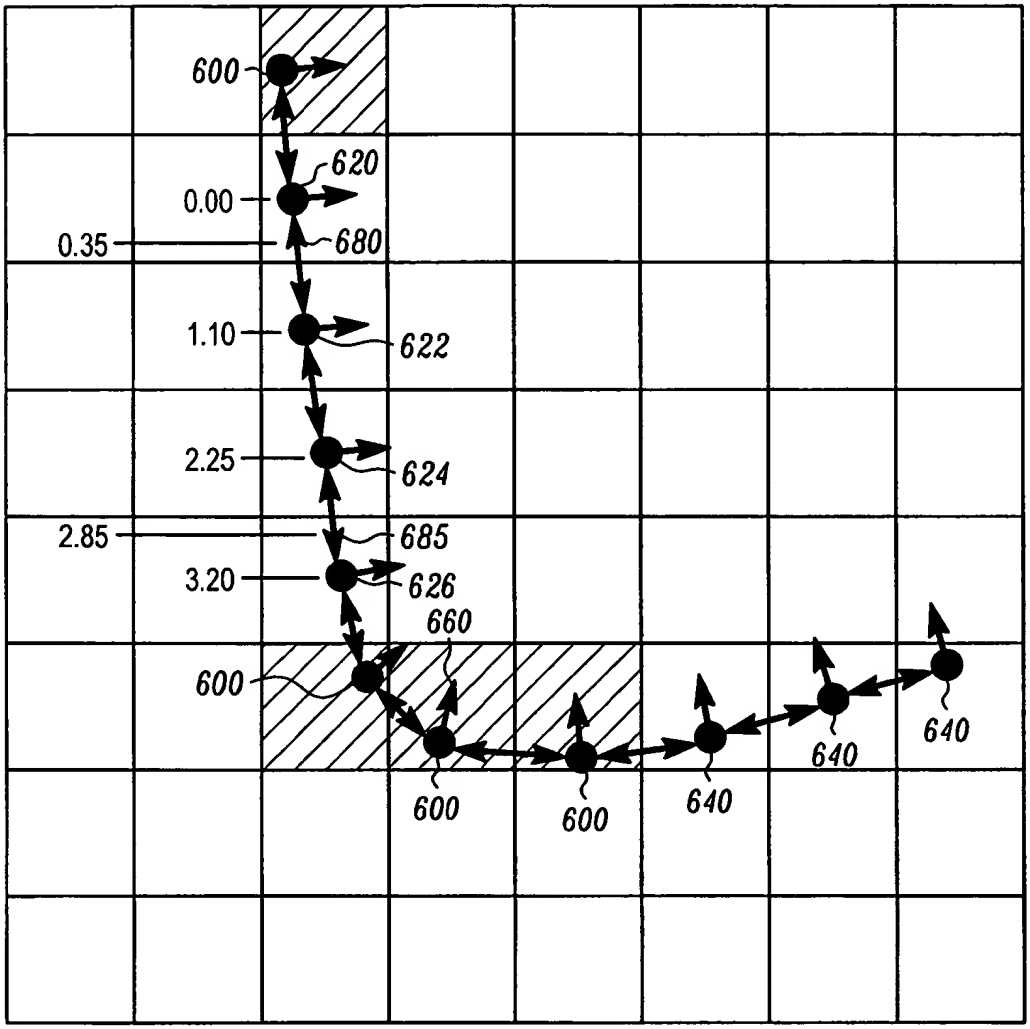
NEIGHBOR ZONES 1

FIG. 5B



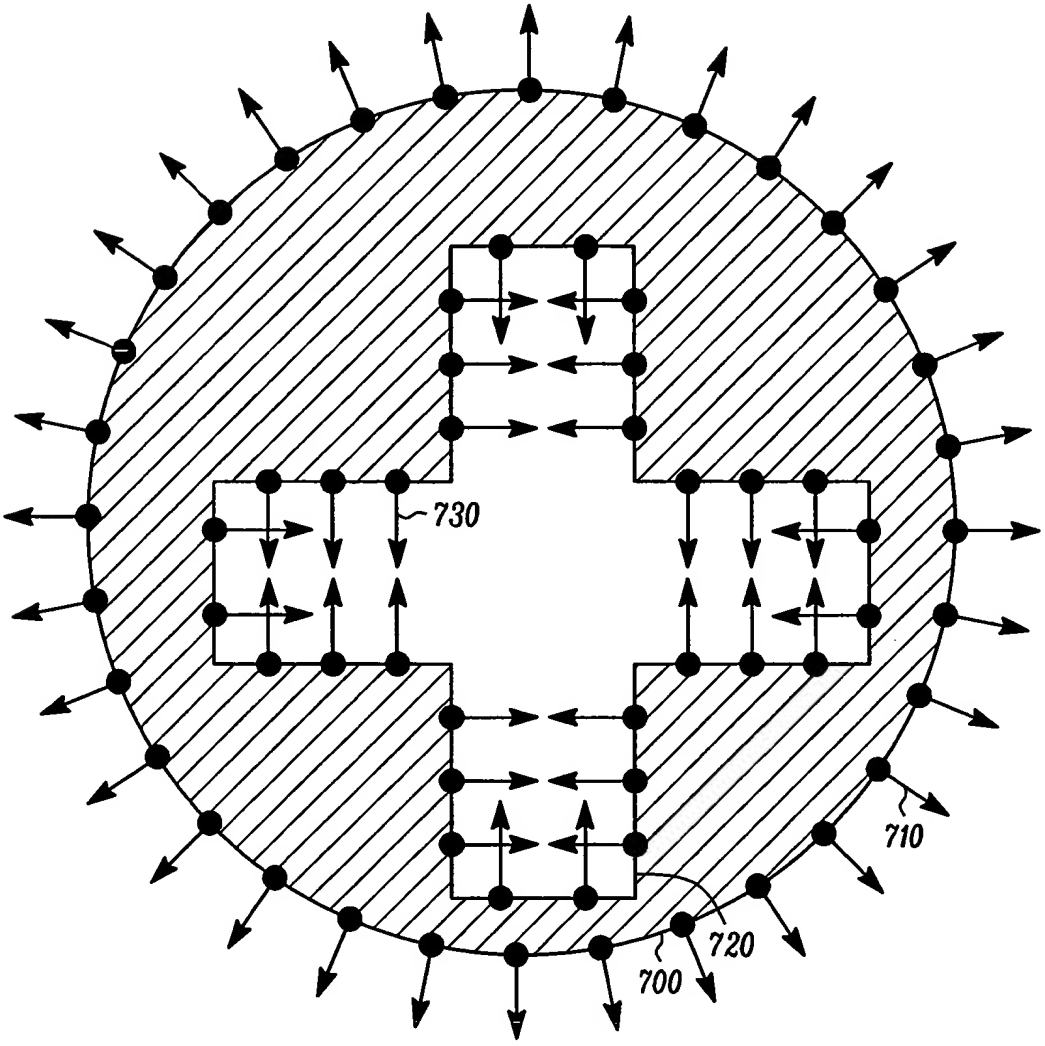
NEIGHBOR ZONES 2

FIG. 5C



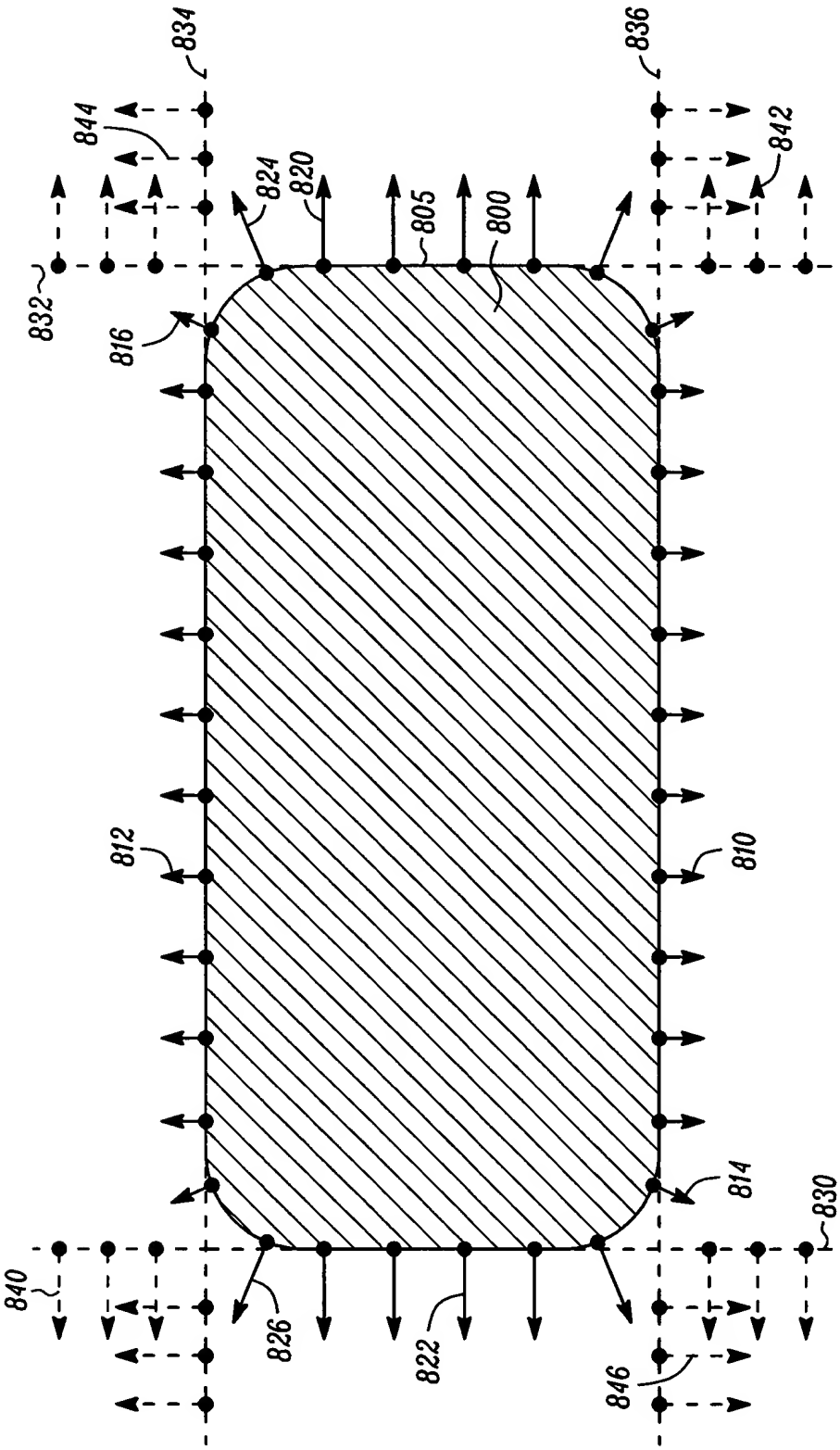
CHAIN SEGMENTATION AND PROBE SELECTION

FIG. 6



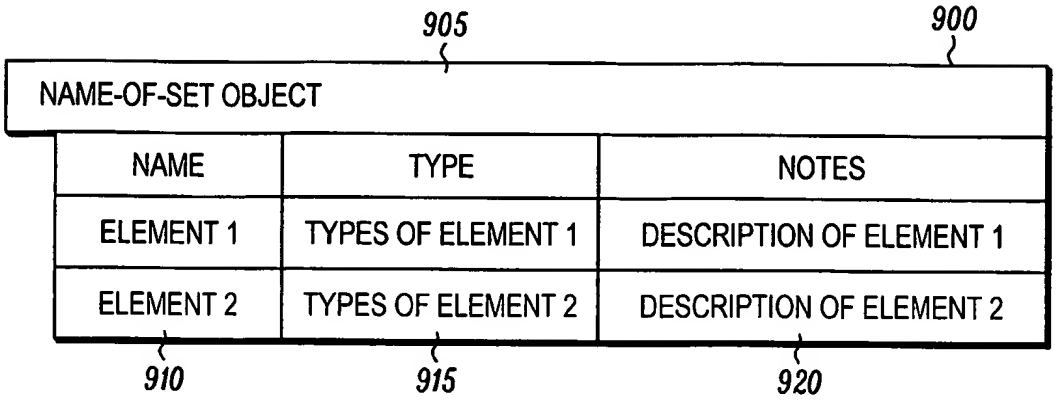
PROBE PLACEMENT

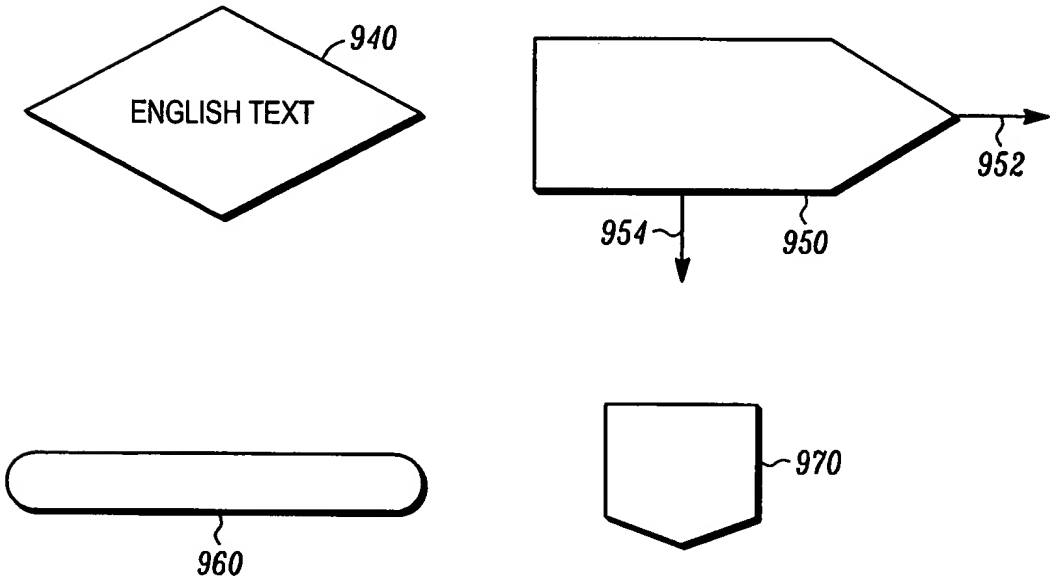
FIG. 7



PROBE PLACEMENT FOR SYNTHETIC TRAINING OF ROUNDED RECTANGLE

FIG. 8





TYPOGRAPHIC AND SYMBOLIC CONVENTIONS

FIG. 9

MODEL OBJECT			
	NAME	TYPE	NOTES
1000	PROBES	LIST OF PROBE OBJECTS	PROBES CREATED BY TRAINING STEP 370
1010	GRANULARITY	REAL NUMBER	GRANULARITY CHOSEN DURING TRAINING STEP 300
1020	CONTRAST	REAL NUMBER	CONTRAST OF TRAINING PATTERN DETERMINED IN TRAINING STEP 380

120

MODEL

FIG. 10

PROBE OBJECT			
	NAME	TYPE	NOTES
1100	POSITION	REAL 2-VECTOR	PROBE POSITION, PATTERN COORDS
1110	DIRECTION	BINARY ANGLE	EXPECTED GRADIENT DIRECTION, PATTERN COORDS
1120	WEIGHT	REAL NUMBER	PROBE WEIGHT, POSITIVE OR NEGATIVE

1190

PROBE

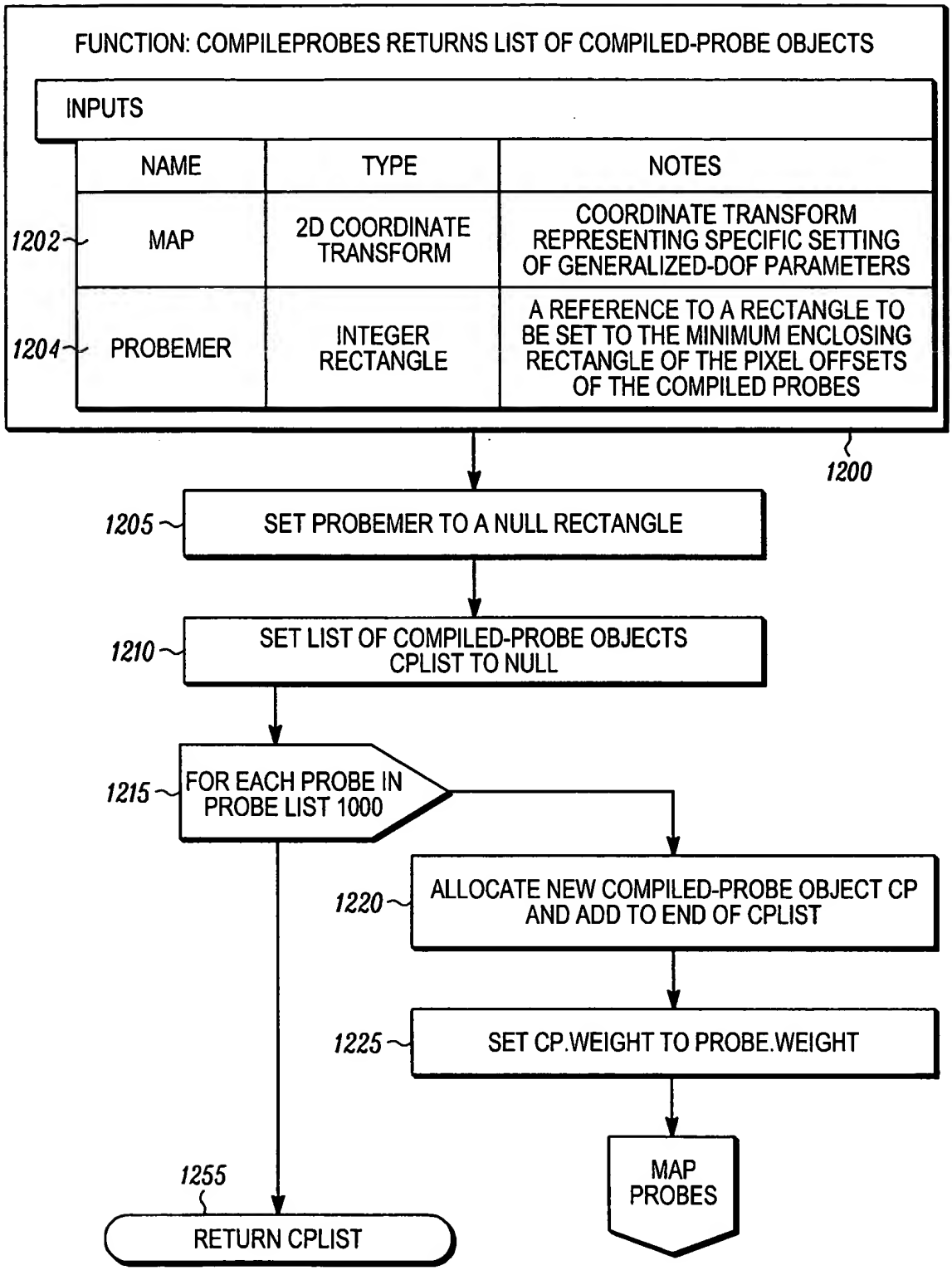
FIG. 11A

COMPILED-PROBE OBJECT			
	NAME	TYPE	NOTES
1130	OFFSET	INTEGER	MAPPED IMAGE PIXEL ADDRESS OFFSET
1140	DIRECTION	BINARY ANGLE	MAPPED GRADIENT DIRECTION
1150	WEIGHT	INTEGER	RELATIVE WEIGHT

1195

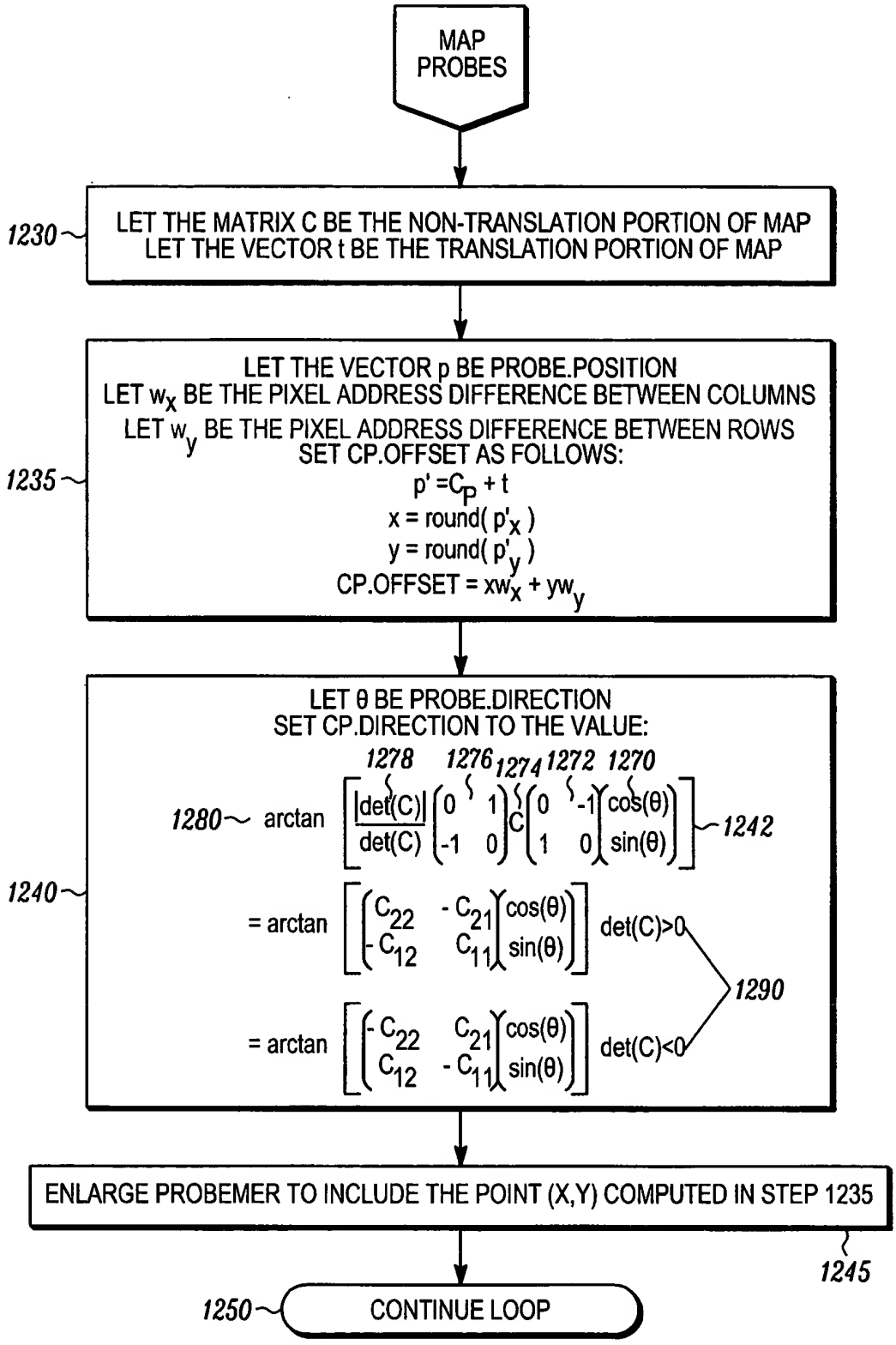
COMPILED PROBE

FIG. 11B



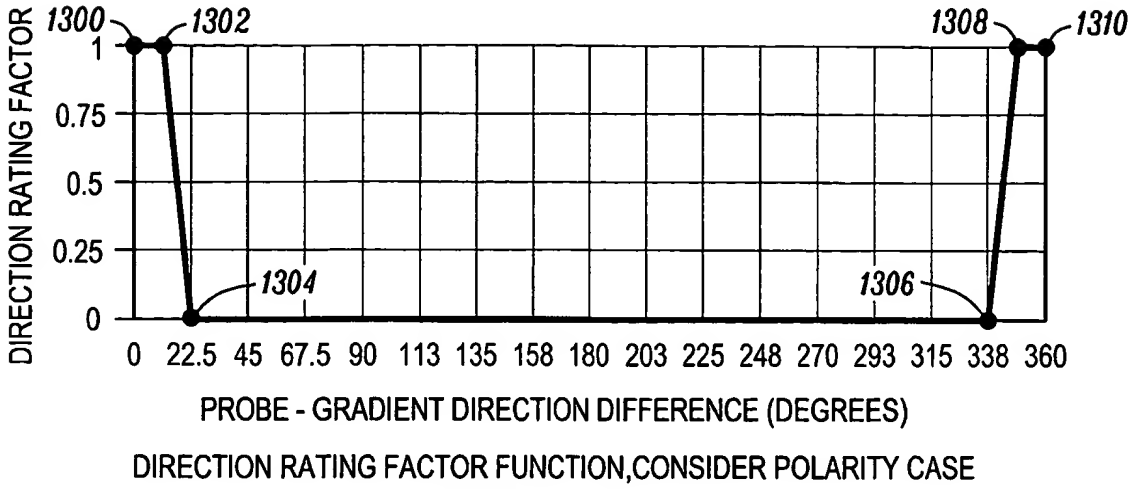
PROBE COMPILER

FIG. 12A



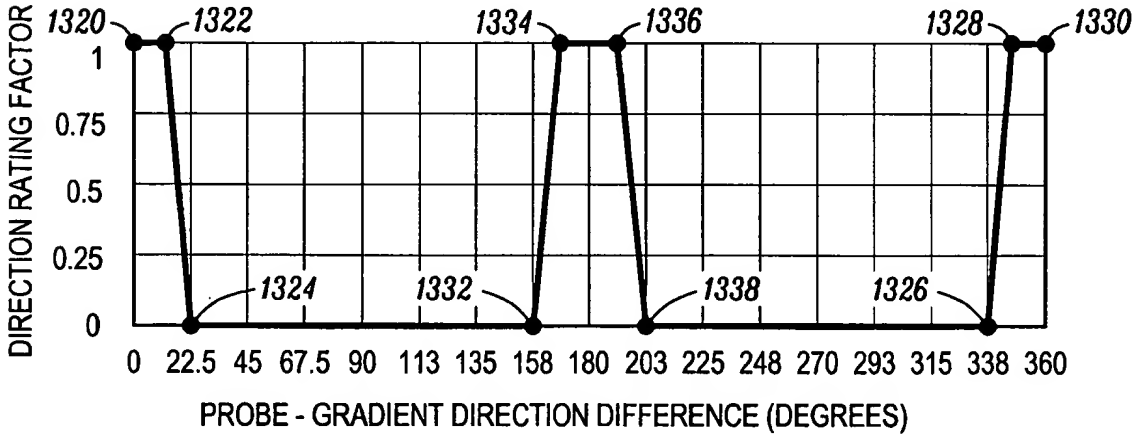
PROBE COMPILER CONTINUED

FIG. 12B



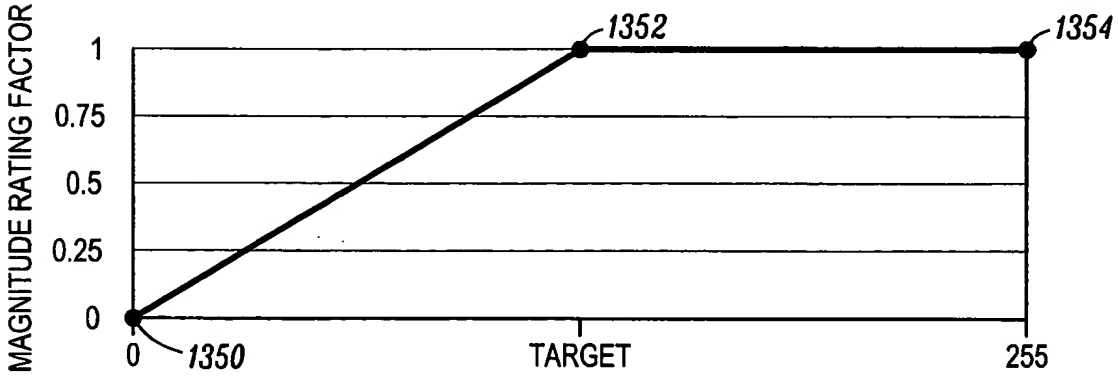
DIRECTION RATING FACTOR FUNCTION,CONSIDER POLARITY CASE

FIG. 13A



DIRECTION RATING FACTOR FUNCTION, IGNORE POLARITY CASE

FIG. 13B



MAGNITUDE RATING FACTOR FUNCTION

FIG. 13C

GENERALIZED-DOF OBJECT			
	NAME	TYPES	NOTES
1400	LOW	REAL NUMBER	REQUESTED LOW END OF SEARCH RANGE
1405	HIGH	REAL NUMBER	REQUESTED HIGH END OF SEARCH RANGE
1410	MAXSTEPSIZE	REAL NUMBER	MAXIMUM STEP SIZE
1415	DUPRANGE	REAL NUMBER	DUPLICATE DETECTION RANGE
1420	START	REAL NUMBER	ACTUAL LOW END OF SEARCH RANGE
1430	NUMCOARSESTEPS	INTEGER	NUMBER OF COARSE STEPS FROM START TO STOP
1435	STEPSIZE	REAL NUMBER	ACTUAL STEP SIZE,DERIVED FROM MAXSTEPSIZE AND PARAMETER RANGE
1440	CYCLE	REAL NUMBER	IF DOF IS CYCLIC VALUE FOR ONE CYCLE; ELSE 0
1445	MAPPER	2D-COORDINATE-TRANSFORM-VALUED FUNCTION OF REAL ARGUMENT	CONVERT DOF PARAMETER TO CORRESPONDING TRANSFORM
1450	STEPSIZEMATRIX	2 X 2-MATRIX	MATRIX FOR COMPUTING MAX STEP SIZE
1455	STEPSIZEFACTOR	REAL NUMBER	CONVERSION FACTOR FOR COMPUTING MAX STEP SIZE
1460	SCALEFACTOR	REAL-VALUED FUNCTION	"AVERAGE" SCALE FACTOR BASED ON SETTINGS OF LOW AND HIGH

1490

GENERERALIZED-DOF

FIG. 14

	1500 PARAMETER		1440 CYCLE	1445 MAPPER (X)	1450 STEPSIZEMATRIX	1455 STEPSIZEFACTOR	1460 SCALEFACTOR ( )
1540	ROTATION	ANGLE, DEGREES	360	$\begin{pmatrix} \cos(x) & -\sin(x) \\ \sin(x) & \cos(x) \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$	$180/\pi$	1
1545	SHEAR	ANGLE, DEGREES	360	$\begin{pmatrix} 1 & -\tan(x) \\ 0 & 1 \end{pmatrix}$	$\begin{pmatrix} 0 & 1 \\ 0 & 0 \end{pmatrix}$	$180/\pi$	1
1550	LOG SIZE	LOG SCALE FACTOR	0	$\begin{pmatrix} e^x & 0 \\ 0 & e^x \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	1	$e^{\frac{LOW+HIGH}{2}}$
1555	LOG x SIZE	LOG SCALE FACTOR	0	$\begin{pmatrix} e^x & 0 \\ 0 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$	1	$e^{\frac{LOW+HIGH}{4}}$
1560	LOG y SIZE	LOG SCALE FACTOR	0	$\begin{pmatrix} 1 & 0 \\ 0 & e^x \end{pmatrix}$	$\begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$	1	$e^{\frac{LOW+HIGH}{4}}$
1565	LOG ASPECT	LOG RATIO y TO x SCALE FACTOR	0	$\begin{pmatrix} e^{-x/2} & 0 \\ 0 & e^{x/2} \end{pmatrix}$	$\begin{pmatrix} 1/2 & 0 \\ 0 & -1/2 \end{pmatrix}$	1	1
1570	SIZE	SCALE FACTOR	0	$\begin{pmatrix} x & 0 \\ 0 & x \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$	1	$\sqrt{LOW \cdot HIGH}$
1575	x SIZE	SCALE FACTOR	0	$\begin{pmatrix} x & 0 \\ 0 & 1 \end{pmatrix}$	$\begin{pmatrix} 1 & 0 \\ 0 & 0 \end{pmatrix}$	1	$\sqrt[4]{LOW \cdot HIGH}$
1580	y SIZE	SCALE FACTOR	0	$\begin{pmatrix} 1 & 0 \\ 0 & x \end{pmatrix}$	$\begin{pmatrix} 0 & 0 \\ 0 & 1 \end{pmatrix}$	1	$\sqrt[4]{LOW \cdot HIGH}$
1585	ASPECT	RATIO y TO x SCALE FACTOR	0	$\begin{pmatrix} x^{-1/2} & 0 \\ 0 & x^{1/2} \end{pmatrix}$	$\begin{pmatrix} 1/2 & 0 \\ 0 & -1/2 \end{pmatrix}$	1	1

FIG. 15 DATA FOR SPECIFIC GENERALIZED-DOFS

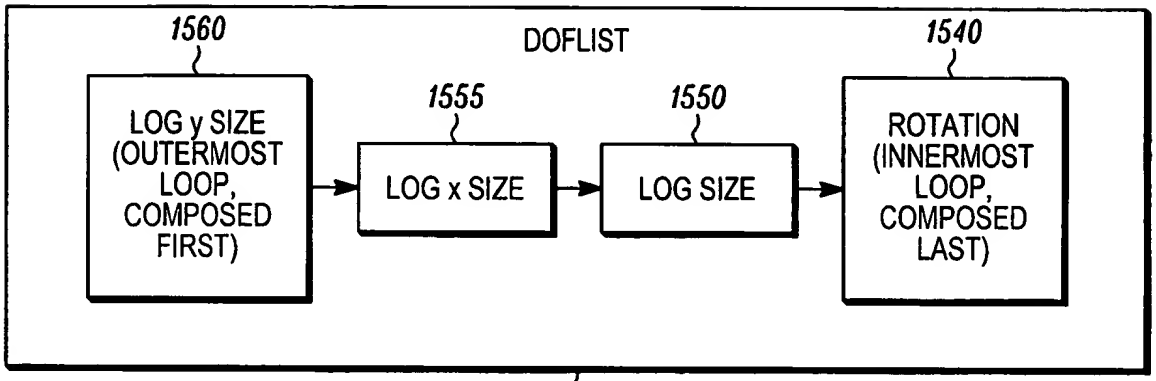


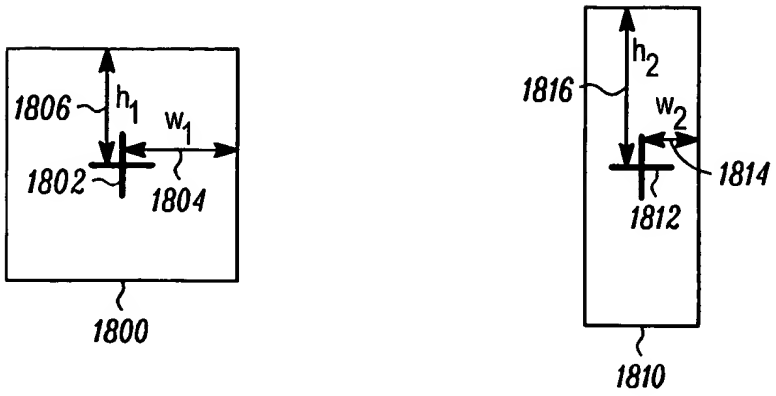
FIG. 16

RESULT OBJECT			
	NAME	TYPE	NOTES
1700	POSITION	REAL 2-VECTOR	PROBE ORIGIN AT MATCH POSITION, IMAGE COORDS
1710	PROBEMER	REAL RECTANGLE	MIN. ENCLOSING RECTANGLE OF PROBES AT MATCH POSITION, IMAGE COORDS
1720	SCORE	REAL NUMBER	MATCH SCORE
1730	CONTRAST	REAL NUMBER	WEIGHTED MEDIAN GRADIENT MAGNITUDE UNDER POSITIVE PROBES
1740	DOFPARAMETERS	LIST OF REAL NUMBERS	DOF PARAMETERS AT MATCH POSE
1750	DOFINDICES	LIST OF INTEGERS	DOF STEP INDICES AT MATCH POSE
1760	PROBERATINGS	LIST OF REAL NUMBERS	LIST OF INDIVIDUAL PROBE RATINGS $R_{mag} * R_{dir}$ FROM THIRD MATCH FUNCTION S_3

1790

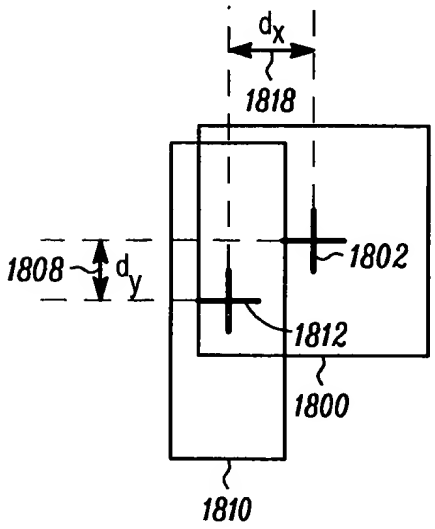
RESULT

FIG. 17



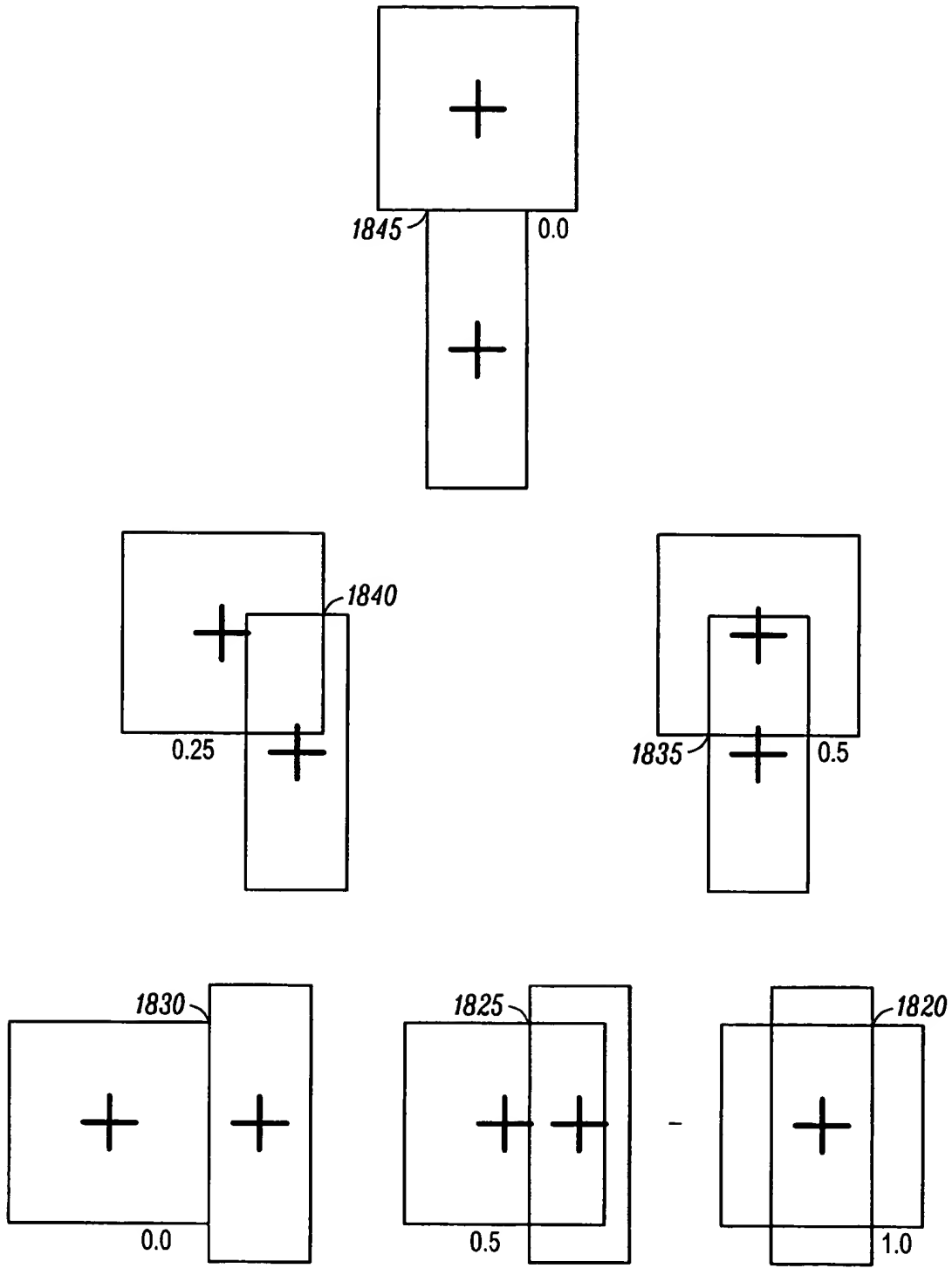
OVERLAP CALCULATION

FIG. 18A



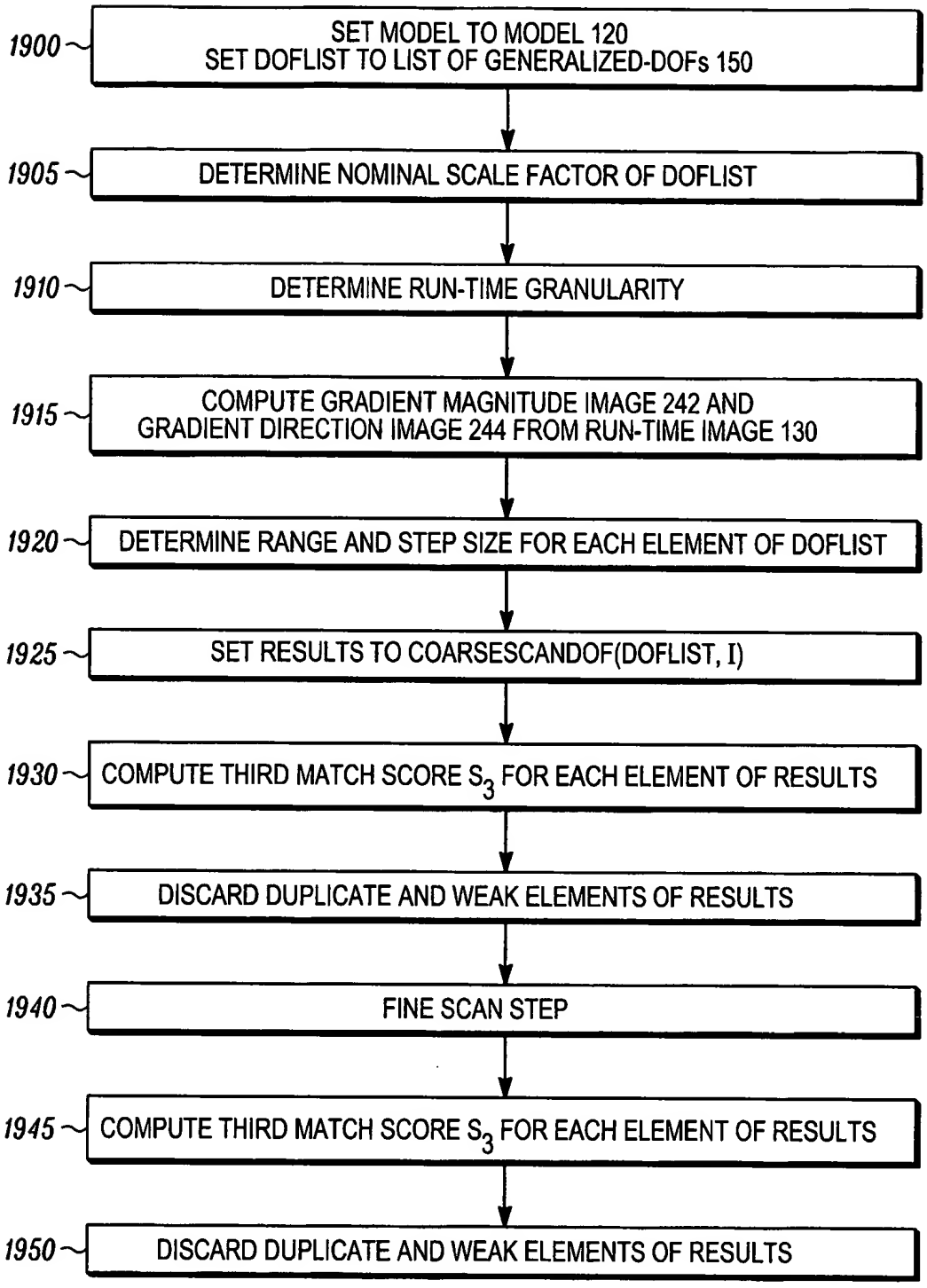
OVERLAP CALCULATION

FIG. 18B



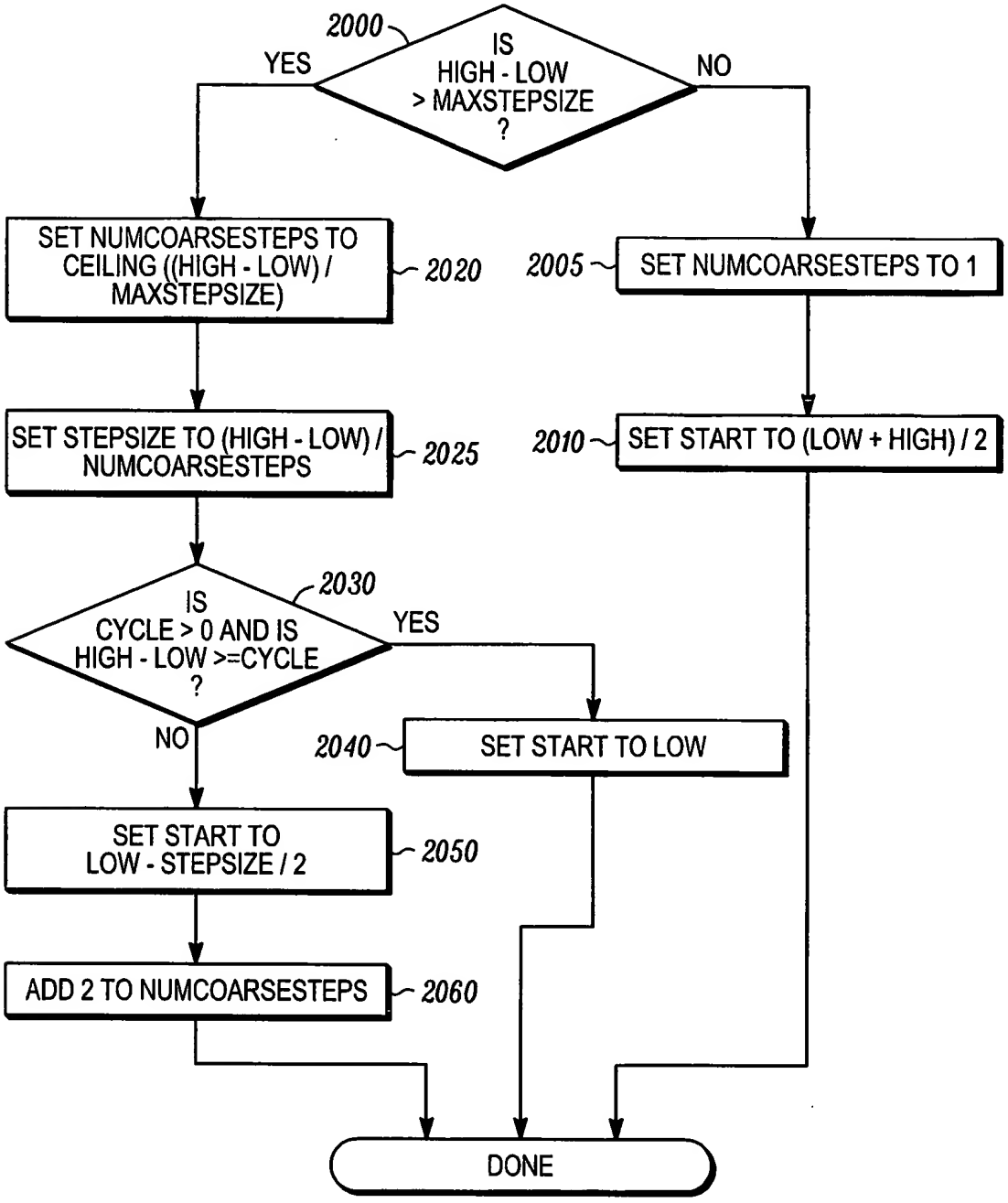
OVERLAP EXAMPLES

FIG. 18C



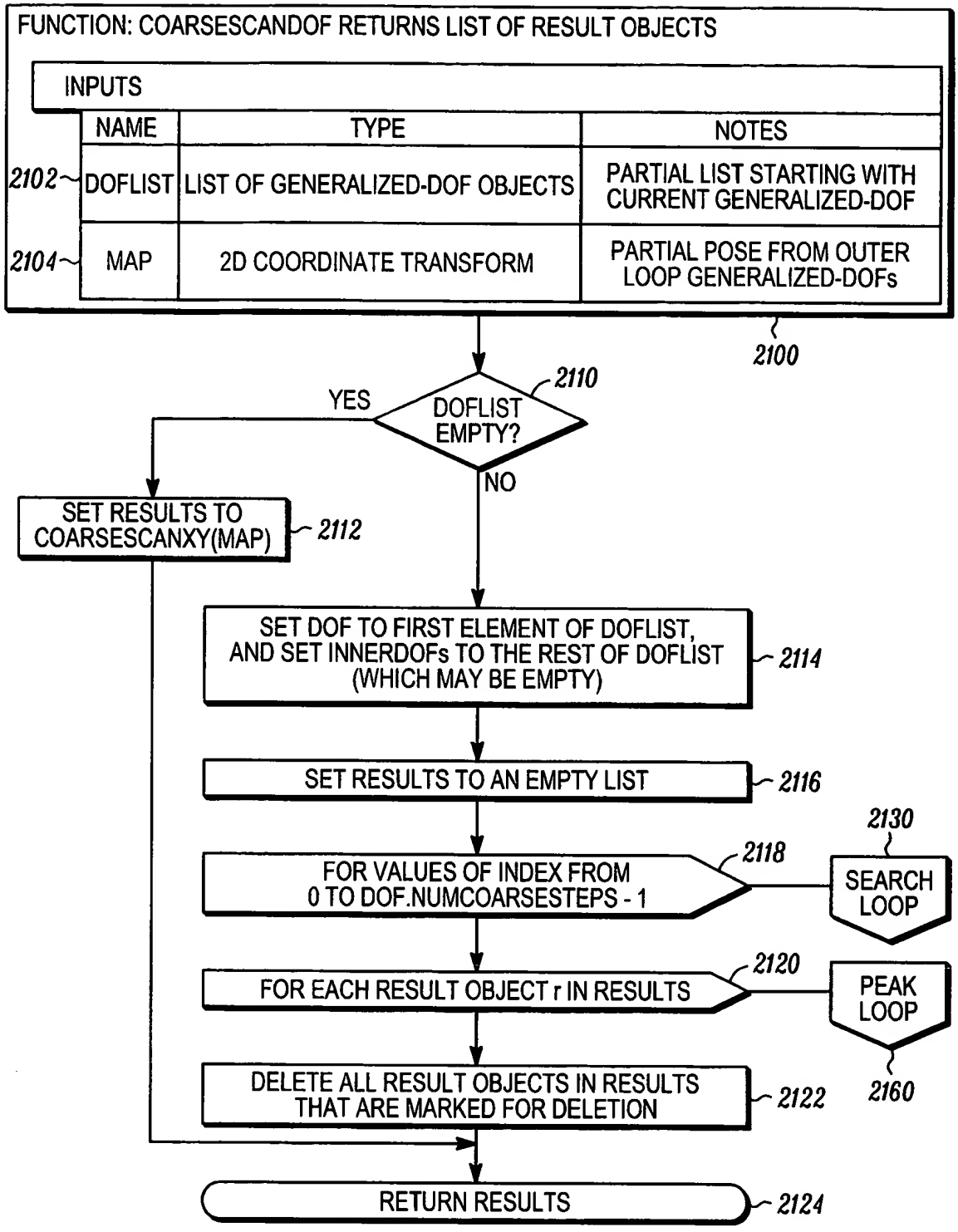
FLOW CHART OF RUN-TIME STEP 140

FIG. 19



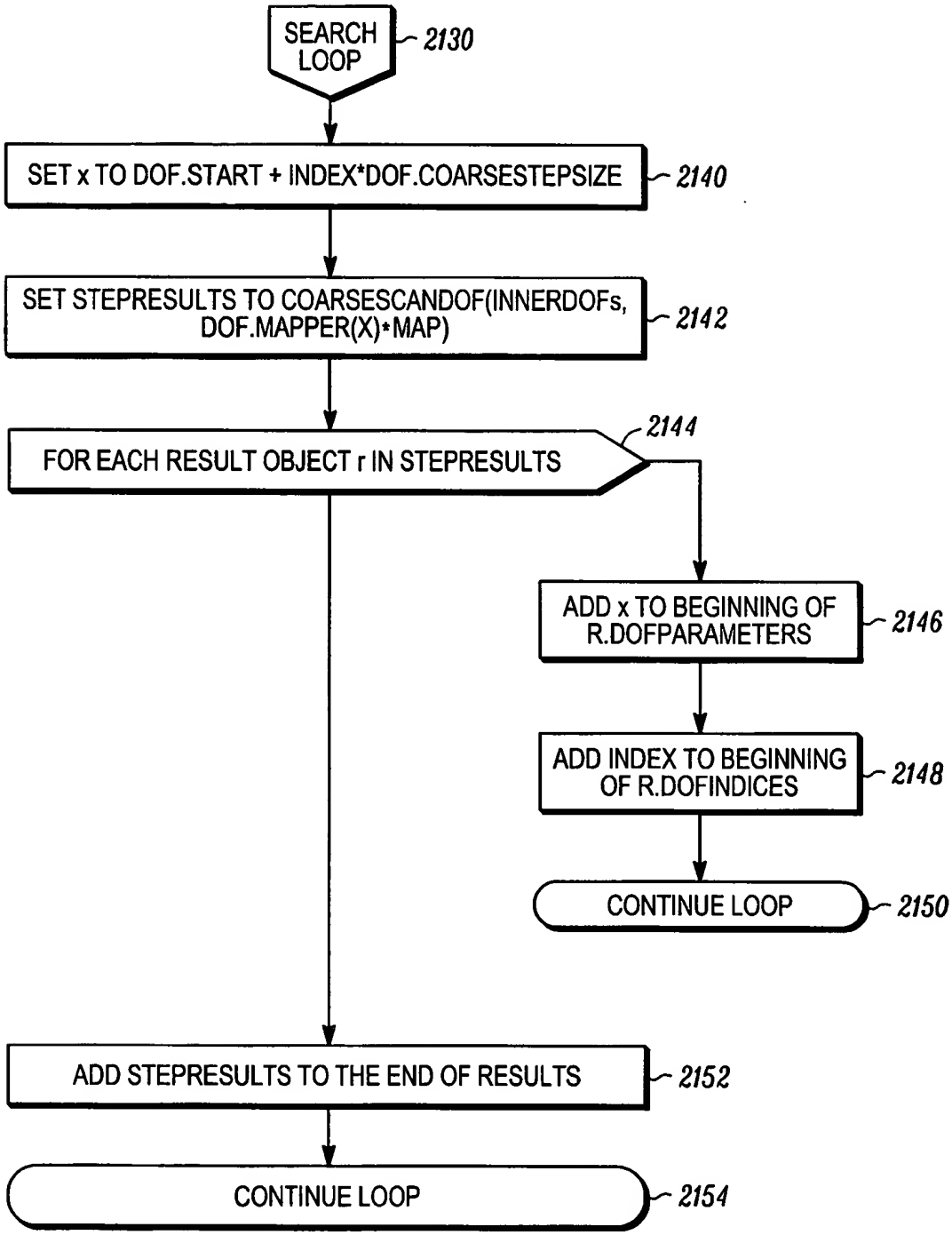
FLOW CHART OF PORTION OF STEP 1920

FIG. 20



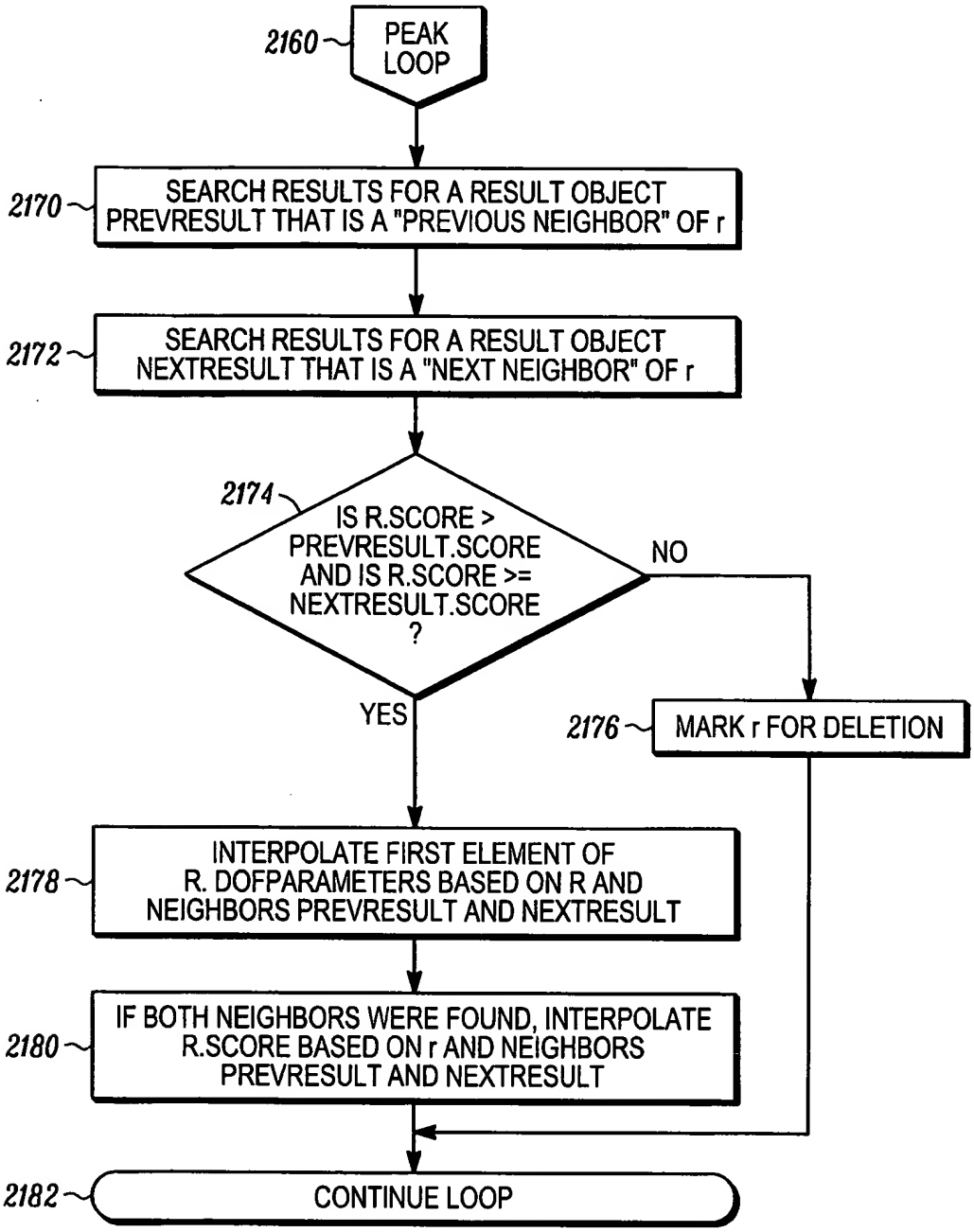
COARSE SCAN GENERALIZED-DOF

FIG. 21A



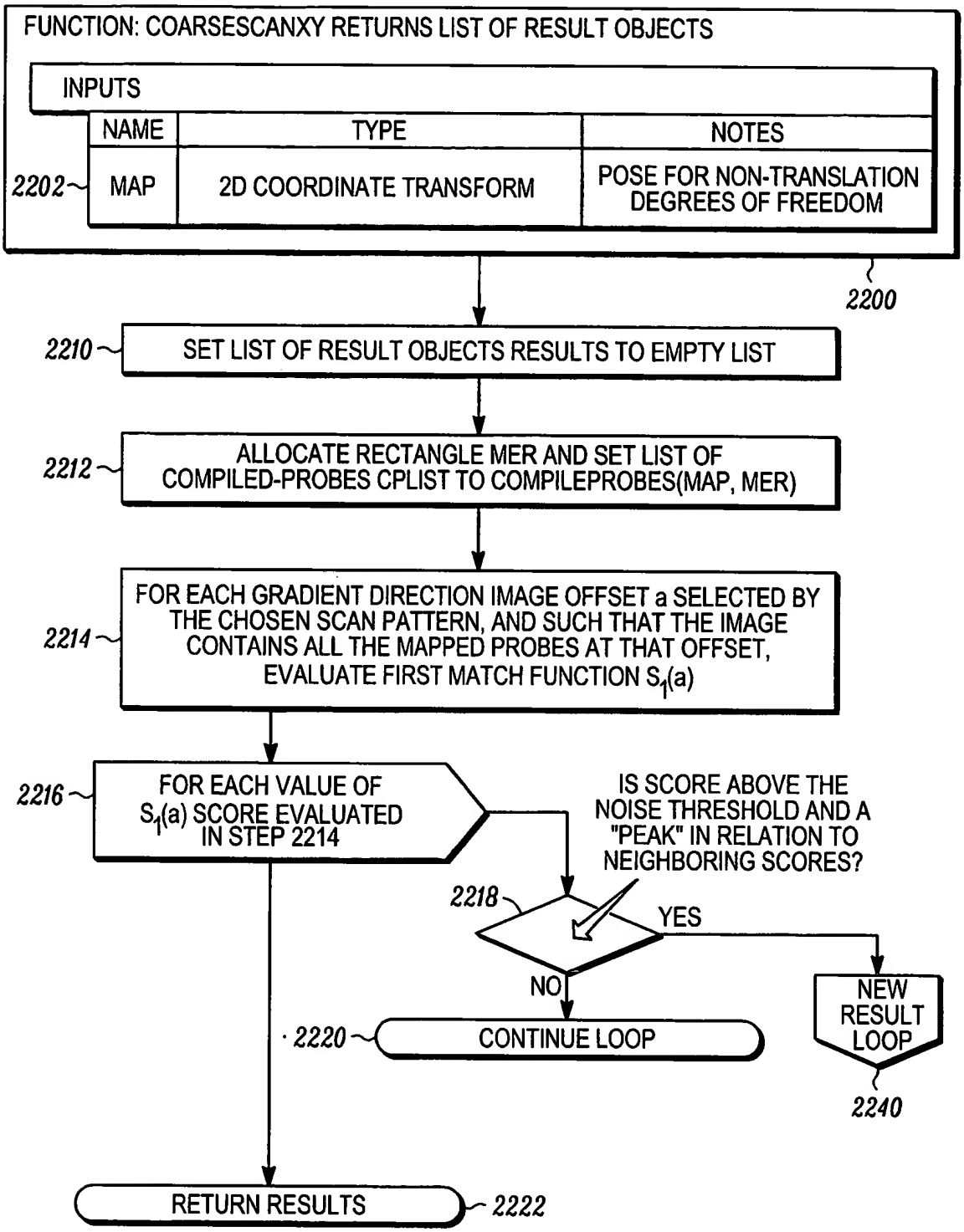
COARSE SCAN GENERALIZED-DOF CONTINUED

FIG. 21B



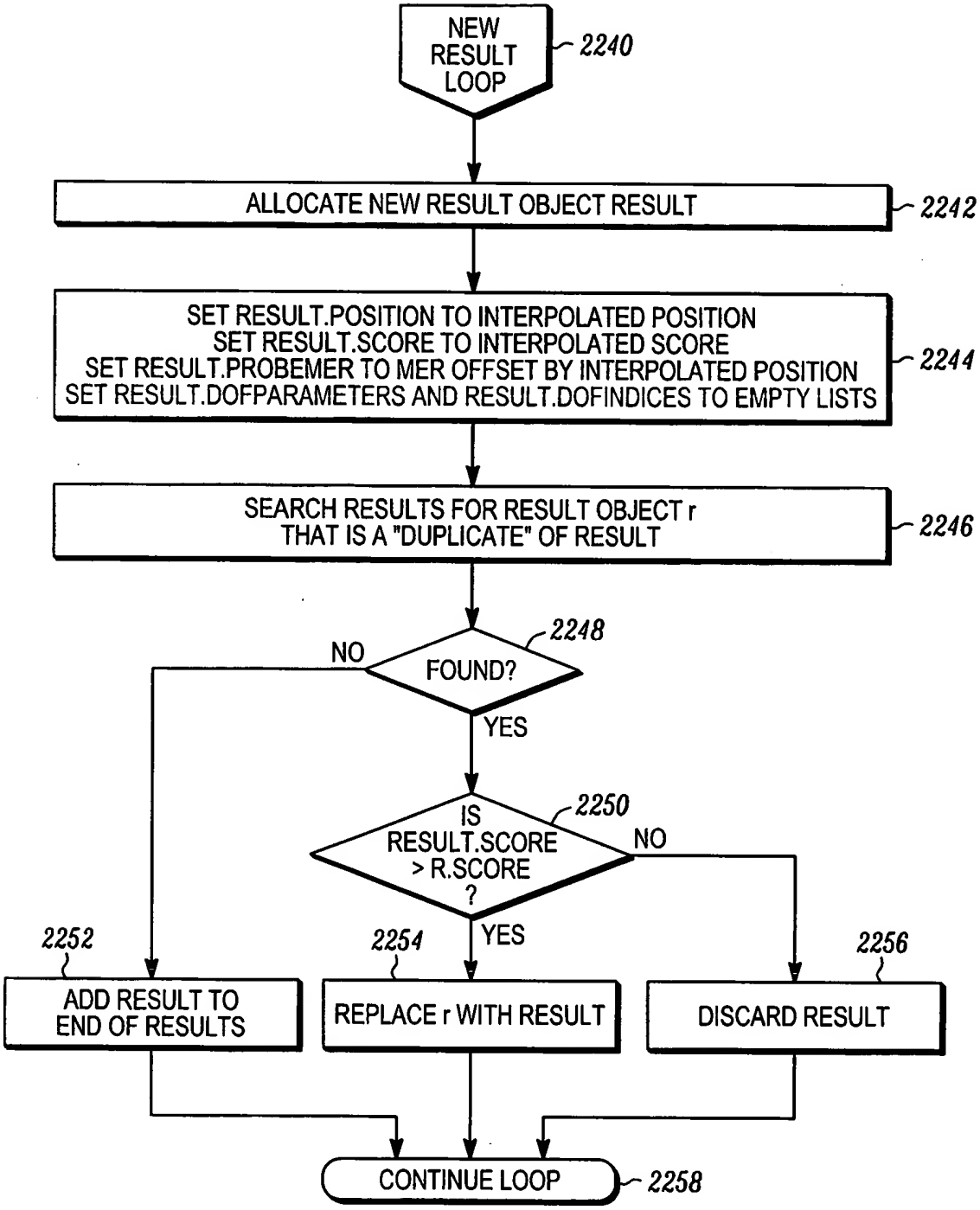
COARSE SCAN GENERALIZED-DOF CONTINUED

FIG. 21C



COARSE SCAN X - Y POSITION

FIG. 22A



COARSE SCAN X - Y POSITION CONTINUED

FIG. 22B

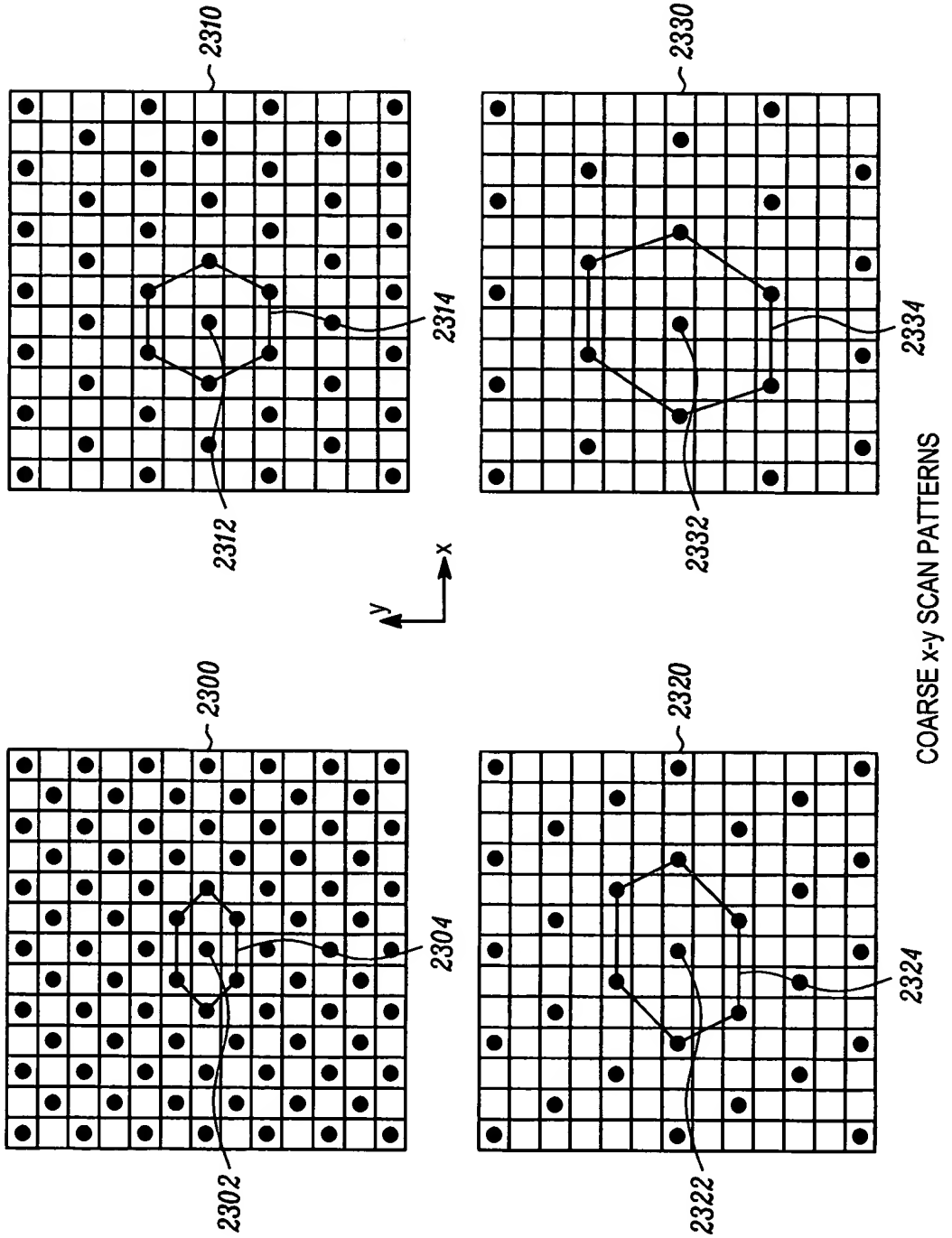
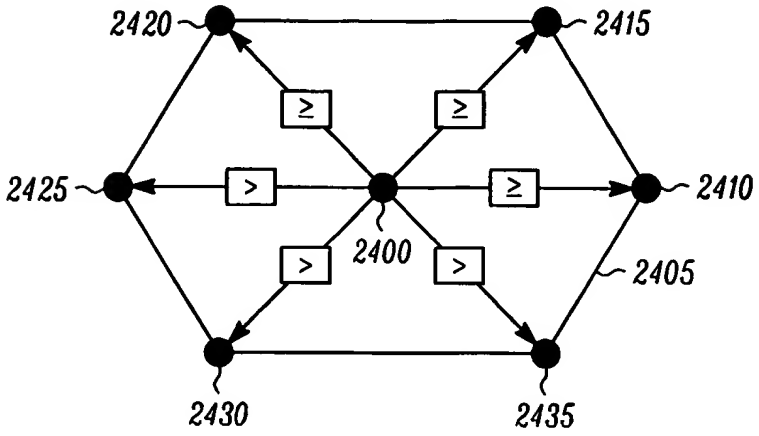
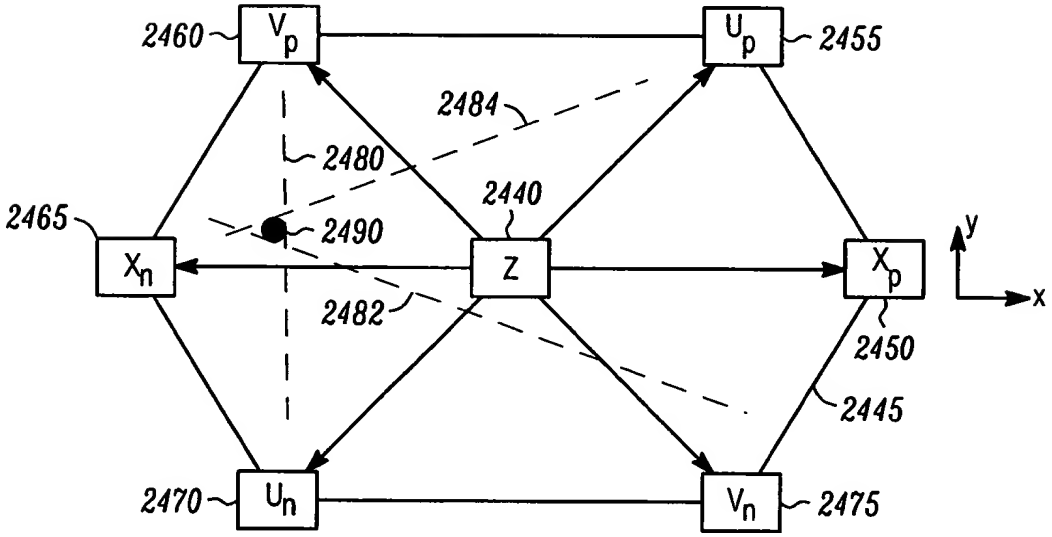

2310
2314
2312
2330
2334
2332
x
y
2300
2304
2302
2320
2324
2322
COARSE x-y SCAN PATTERNS

FIG. 23



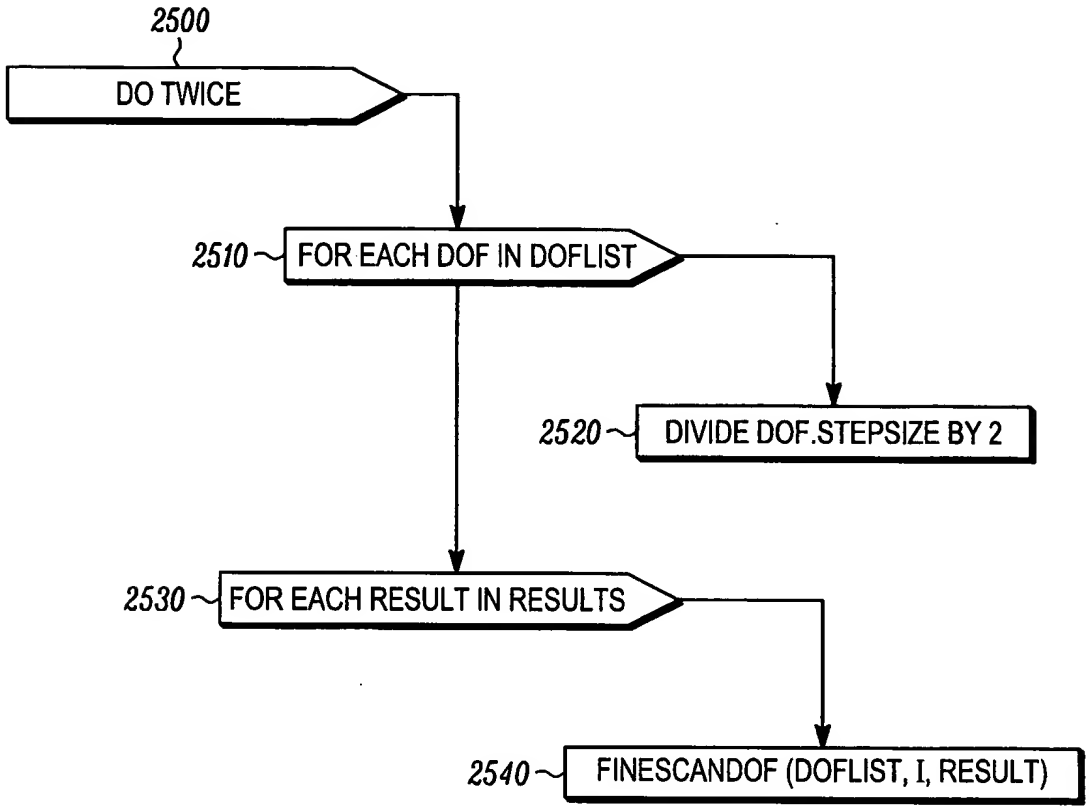
HEXAGONAL PEAK DETECTION

FIG. 24A



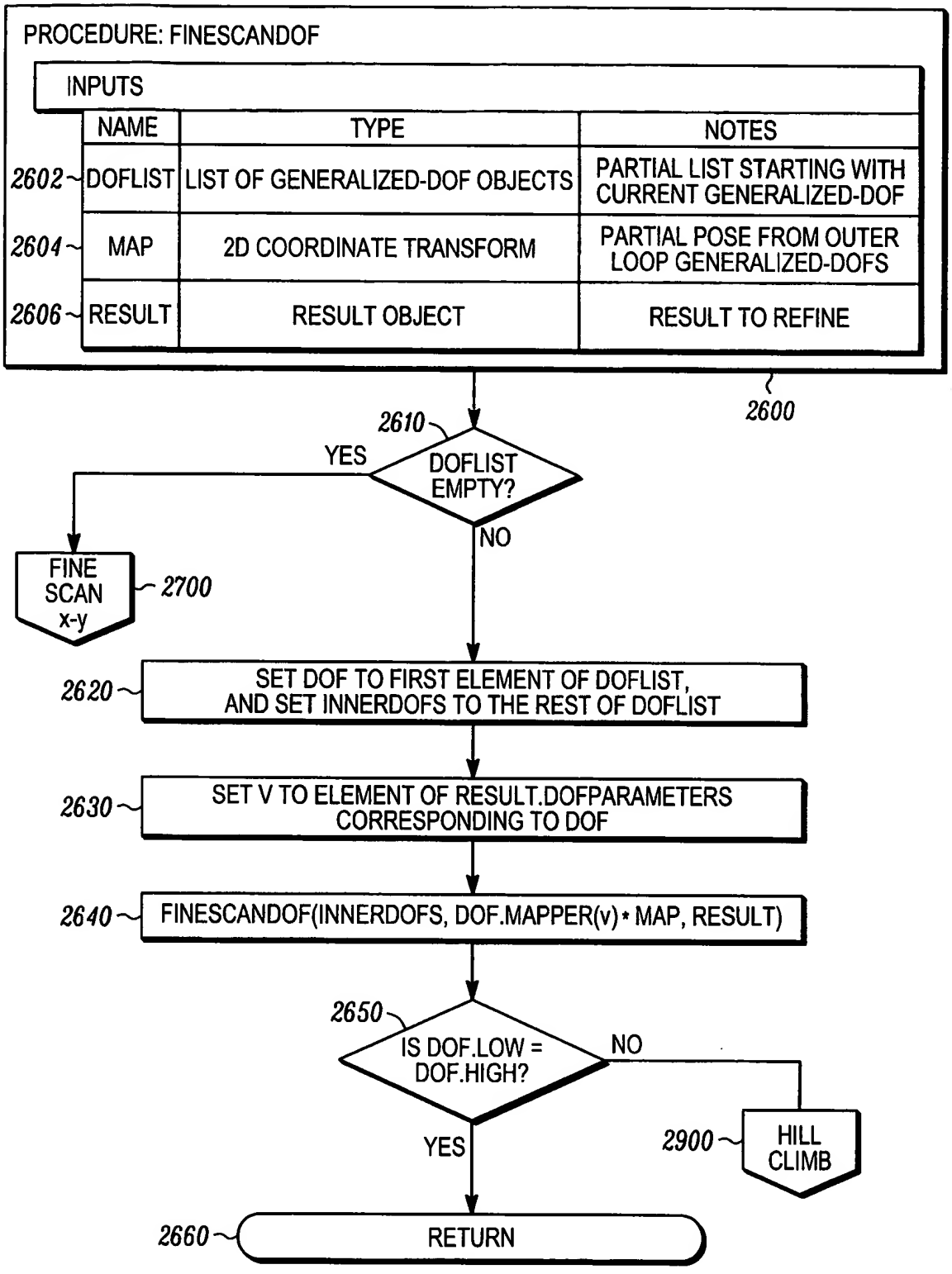
HEXAGONAL INTERPOLATION

FIG. 24B



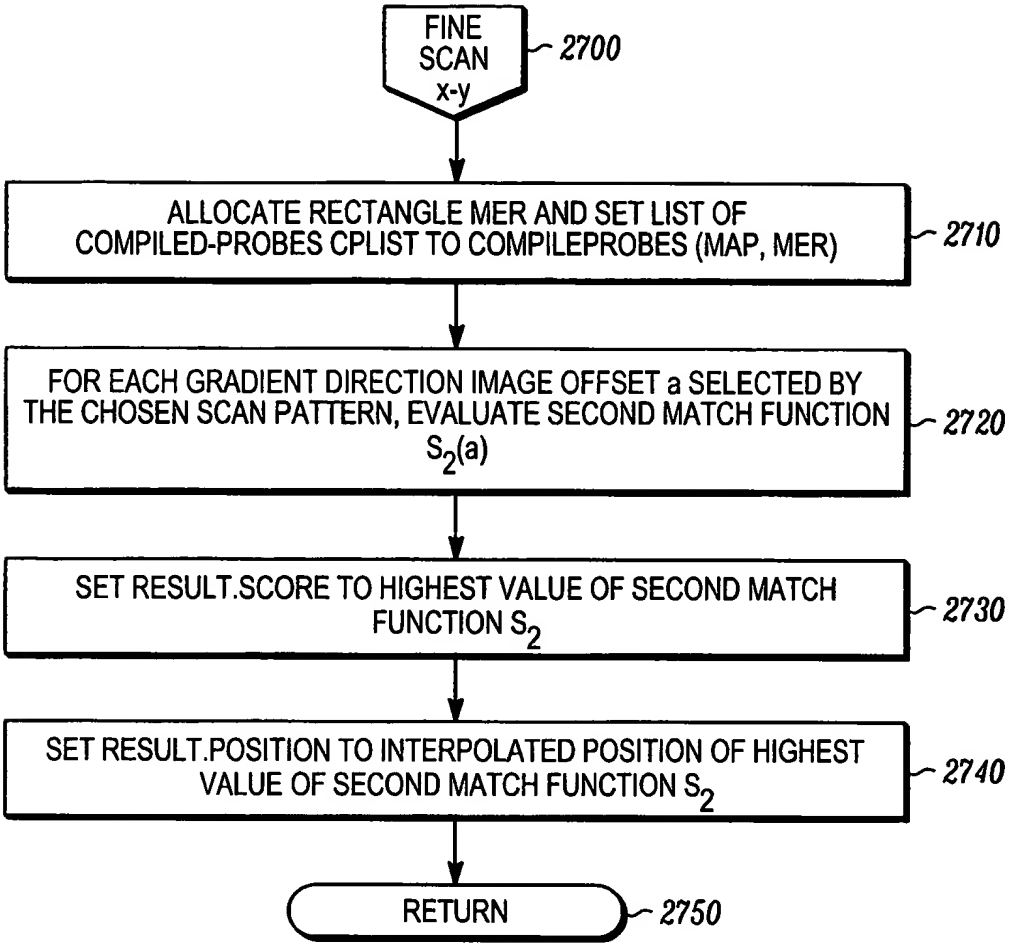
FINE SCAN STEP 1940

FIG. 25



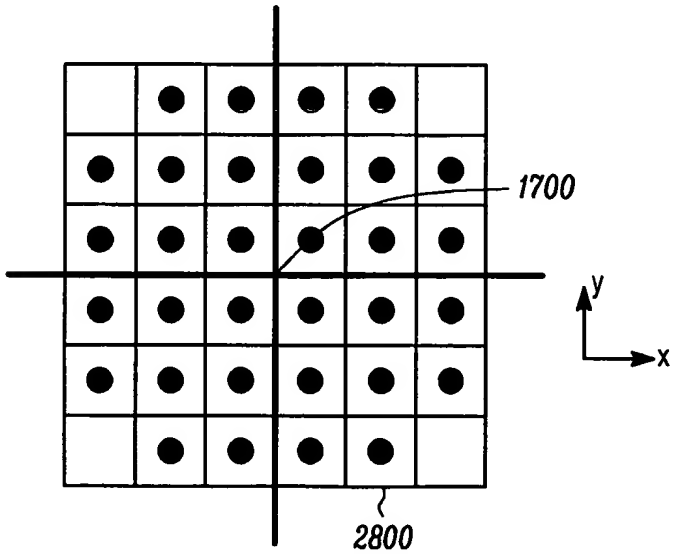
FINE SCAN GENERALIZED-DOF

FIG. 26



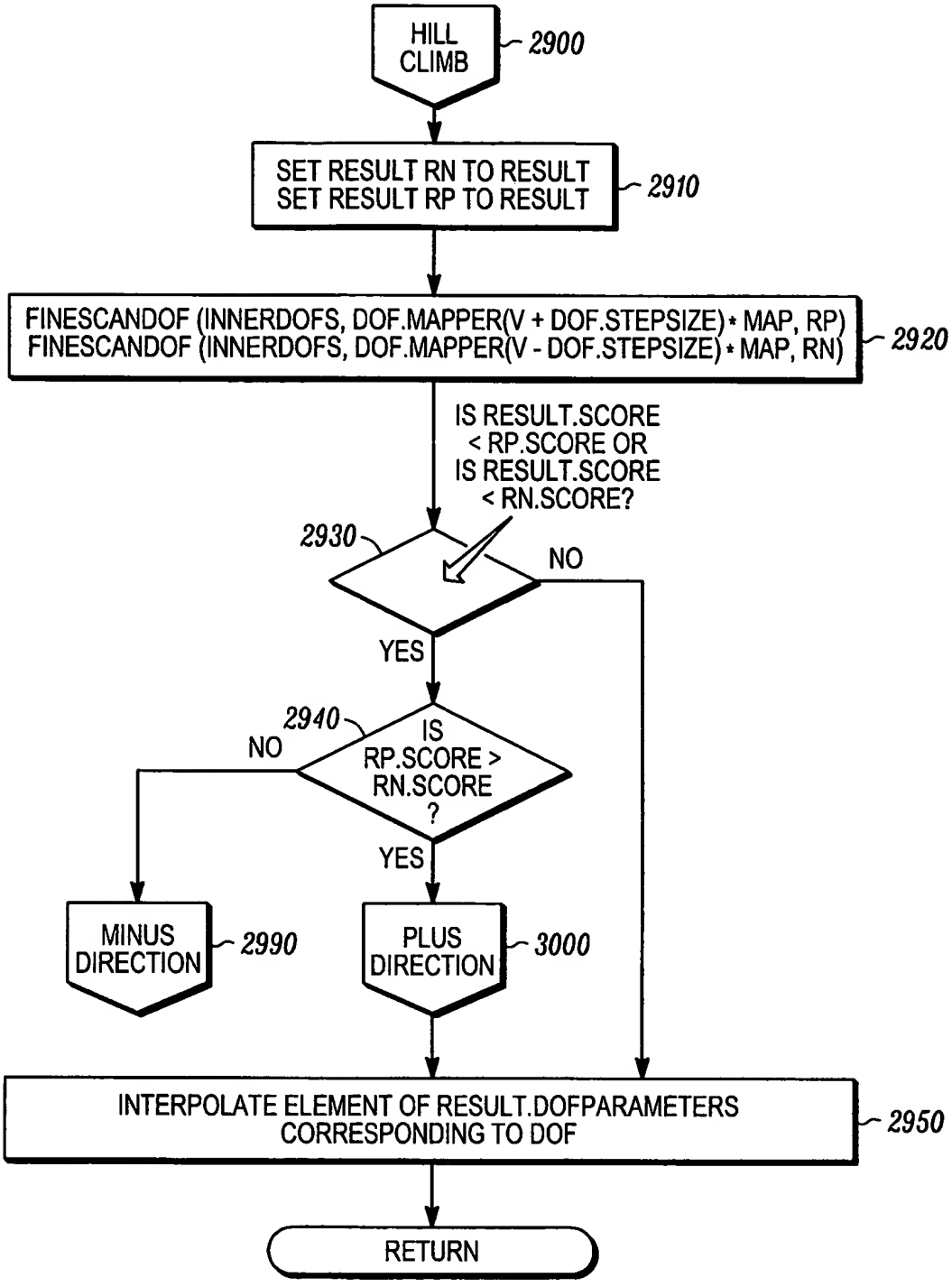
FINE SCAN x-y

FIG. 27



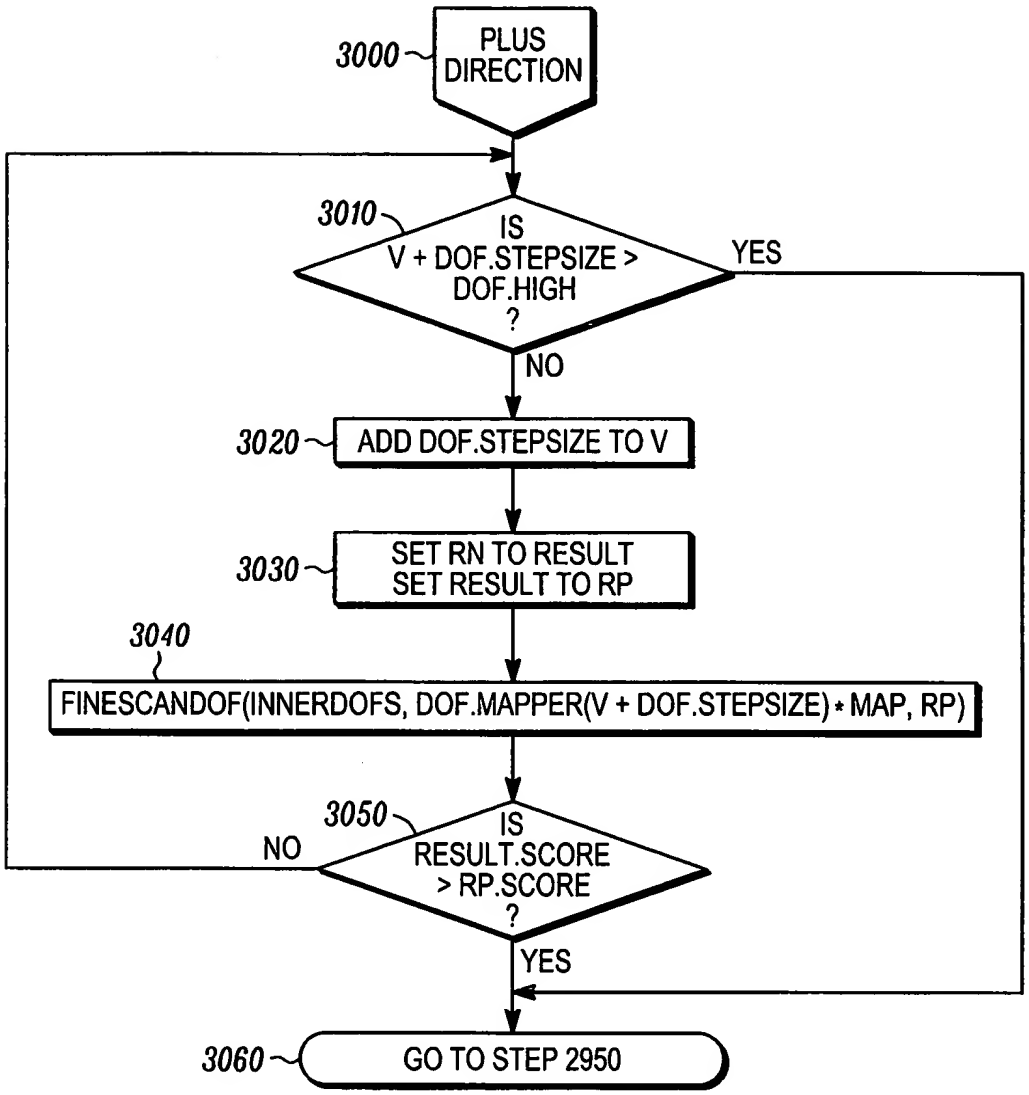
FINE x-y SCAN PATTERN

FIG. 28



FINE SCAN HILL CLIMBING

FIG. 29



FINE SCAN HILL CLIMBING, PLUS DIRECTION

FIG. 30

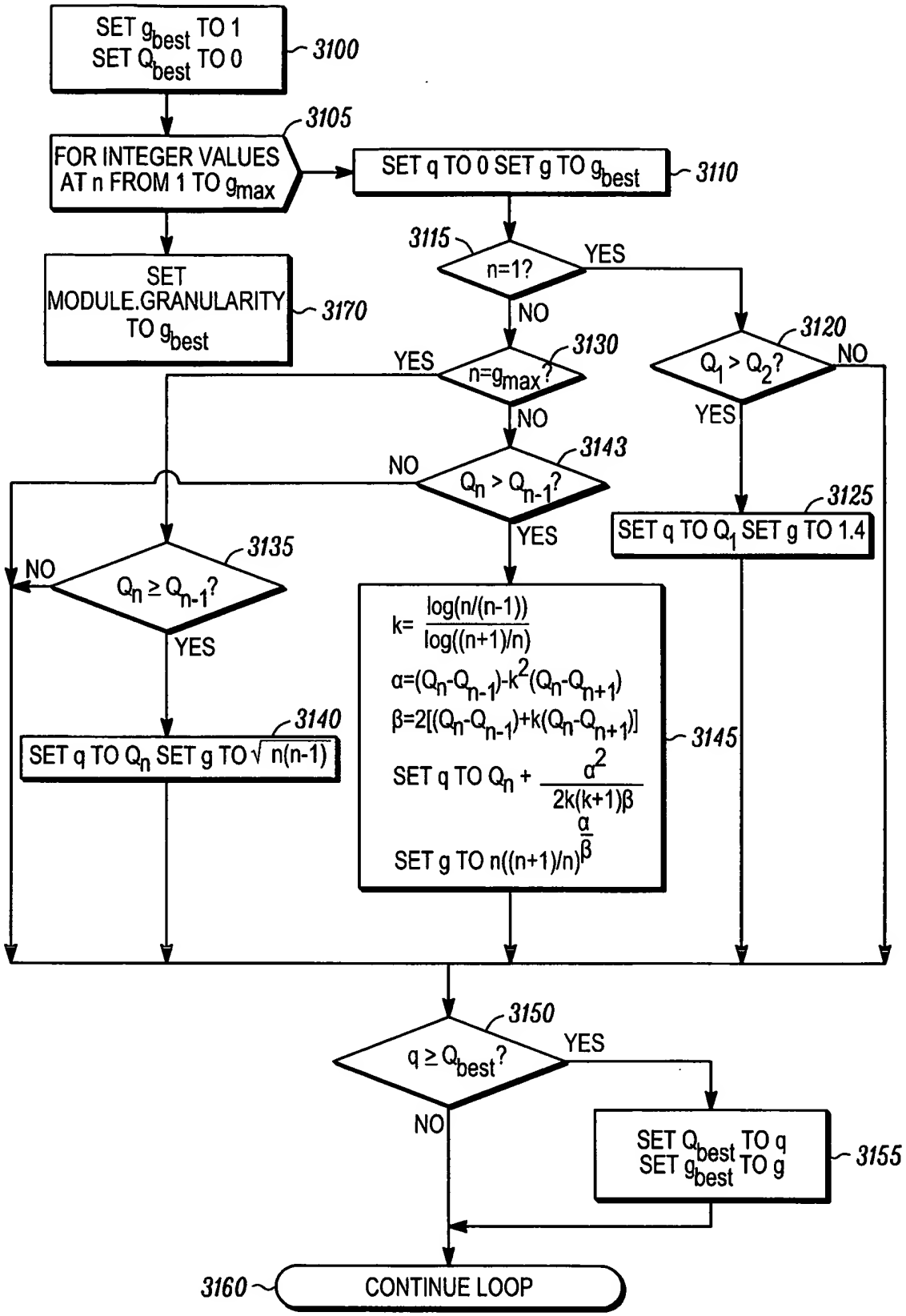

SET g_{best} TO 1
SET Q_{best} TO 0
3100
3105
FOR INTEGER VALUES AT n FROM 1 TO g_{max}
SET q TO 0 SET g TO g_{best}
3110
3115
n=1?
YES
NO
SET MODULE.GRANULARITY TO g_{best}
3170
3120
$Q_1 > Q_2$?
NO
YES
3130
YES
$n=g_{max}$?
NO
3143
NO
$Q_n > Q_{n-1}$?
YES
3125
SET q TO Q_1 SET g TO 1.4
3135
NO
$Q_n \geq Q_{n-1}$?
YES
$k=\frac{\log(n/(n-1))}{\log((n+1)/n)}$
$\alpha=(Q_n-Q_{n-1})-k^2(Q_n-Q_{n+1})$
$\beta=2[(Q_n-Q_{n-1})+k(Q_n-Q_{n+1})]$
SET q TO $Q_n + \frac{\alpha^2}{2k(k+1)\beta}$
SET g TO $n((n+1)/n)^{\frac{\alpha}{\beta}}$
3145
3140
SET q TO Q_n SET g TO $\sqrt{n(n-1)}$
3150
$q \geq Q_{best}$?
YES
NO
SET Q_{best} TO q
SET g_{best} TO g
3155
3160
CONTINUE LOOP

FIG. 31